THE TELEGRAPHIC JOURNAL AND

ELECTRICAL REVIEW.

VOL. XXVIII. JUNE 26, 1891. No. 709

CONTENTS:

	PAGE
The Edison Lamp Suit in America	801
Electric Railway Systems	802
Notes on the Electrolytic Manufacture of Aluminium	803
Telegraphs in the Field	805
A Rough and Ready Dynamometer for Small Motors	805
The Electric Lighting of Budapest	806
A Photographic Study of the Electric Arc (*illustrated*)	807
An Electrolytic Process for obtaining Silver and Copper direct from the Ores	809
Rope Gear for Electric Light Work	810
The Electric Lighting of Dublin	814
Additional Facts concerning the Transmission of Force by Electricity	814
The Edison Incandescent Lamp Patent Case in America	815
London County Council	817
Electricity in the Production of Aluminium	818
Legal:—Action for the Cost of an Electric Lighting Installation	819
Crompton and Co. *v.* Phillips Bros.	819
Parliamentary Notes	821
Royal Agricultural Society's Show	822
Notes	822
City Notes:—House to House Electric Light Company	825
West African Telegraph Company	825
Traffic Receipts	825
Share List of Electrical Companies	826
Proceedings of Societies:—Royal Society	827
Abstracts of Published Specifications	828
Electricity in the Art of Tanning (*illustrated*)	829
The Royal Society's Soirée	830
A Study of an Open Coil Dynamo	831
Correspondence:—Applications of Aluminium	832
Induction in Multiple Core Cables	832

THE EDISON LAMP SUIT IN AMERICA.

ALTHOUGH the counsel for both sides have finished their argument *pro and con*, the Hon. W. J. Wallace, the judge of the Circuit Court, who tried the case without a jury, will not deliver his opinion for a week or two yet. This delay will enable the loser by his judgment to make appeal to the Circuit Court of Appeal, a new court which will have been constituted by then. By doing this companies interested will have the option of a double appeal, and undoubtedly it will furnish a larger quantity of work for the lawyers.

Considering the enormous capital at stake, neither party to the suit can rest satisfied until the last legal step has been taken. The complainant Edison Company has a capital of $12,000,000; the various companies which will suffer should the action be decided adversely to the defendants have a combined capital of about three times that amount, of which the Westinghouse interest is estimated at $7,000,000, and the Thomson-Houston at $20,000,000. In addition to these there are several other companies who manufacture incandescent lamps. If the plaintiff gains the day all these concerns will find their power of competing with the Edison Company seriously diminished, while in all likelihood the solvency of the smaller fry will be heavily jeopardised.

In all former trials, especially those relating to the telephone, the actions have been brought before any very large capital has been invested in the business; but in this one, whether purposely or not, the companies have been beguiled, by the delay in bringing the case to a definite issue, into increasing their works and extending their trade far and wide; and now, after more than 11 years from the date of the patent said to be infringed, a blow is struck which, if it answers its intention, will cripple the future trade of the country in incandescent lamps, and will entail endless trouble to the infringing companies in rendering account of their back sales. A plea might easily be raised to alter the law so that, as in other matters, there should be a Statute of Limitations, by which, after a certain time, a plaintiff would be debarred from taking proceedings; this would hasten action. Or, perhaps, the same purpose would be served equally well by abolishing retrospective damages to a great extent, that is to say, by only allowing the calculations upon which the damages are based to cover a period of one year prior to the date of the commencement of proceedings for infringement of the patent rights.

Unless sentiment prevails with the Courts, it is rather difficult to conceive how it can give to the second claim of the Edison lamp patent so broad a construction as is requisite to cover a modern lamp, for in bringing a suit for infringement it is necessary to base the contest on claims that have been allowed by the Patent Office, and to take into consideration the state of the art at the time. In the M'Keesport case Judge Bradley said: "The claims of the Sawyer-Man patent may be summarised as follows:—1. A conductor of carbon made of fibrous or textile material and of arched form; 2. A conductor of carbon made of fibrous material in a hermetically sealed chamber without regard to form; 3. The combination of a conductor of carbon made of fibrous or textile material in an arched form in a glass chamber hermetically sealed and deprived of carbon consuming gas. The claim of the combination last named may be dismissed as a separate claim, because a glass chamber hermetically sealed for holding the light has always been used, and must necessarily be used in all incandescing carbon electric lamps; it was used by King in 1845, by Konn in 1872, by Kosloff in 1875, and by others. Unless the patent is valid for the conductor of carbon made of textile material in an arched form, it cannot be held valid by combining such conductor with a glass chamber hermetically sealed. The arched or bent shape was used by Staite in 1848 for an iridium conductor, and in 1872 it was an arrangement well known in Science and the Arts. Long prior to 1878 it was a well known fact that the transmission of an electric current through a pencil of charcoal interposed in a metallic circuit would produce intense light, and that when this charcoal was guarded from contact with oxygen, in a vacuum or otherwise, it would not be consumed. The great desideratum was to construct an apparatus and to discover a process which would make the light economical and convenient, and of use for

ordinary domestic purposes. We are clearly of opinion, therefore, that neither Sawyer and Man nor Edison can maintain any such claim to the exclusive use of charcoal generally in any form as the incandescing conductor in a lamp." The Judge pointed out that it was very clear to him that there was a change of base on the part of Sawyer and Man, the complainants in the case, after the issue of the Edison patent, and that he nullified the claims of Sawyer and Man in consideration of early anticipations and their own modifications after Edison's work on the subject. Judge Bradley said that the great thing described in Edison's patent was the attenuated filament and its enclosure in a perfect vacuum, and that his particular invention made practicable the present incandescent lamp.

This decision appears to be to a considerable extent in favour of Edison as compared with the complainants' patent.

Let us turn, now, to the rulings of the Patent Office; these are not always infallible—witness the transformer patent refused to Bernstein, as not possible, and yet in a year or two after issued to another. In 1881 a Mr. W. K. Freeman filed an application for an incandescent lamp, and in an amendment inserted the following claim:—"An electric lamp for giving light by incandescence, consisting of a strip or filament of carbon of high resistance, enclosed within an exhausted receiver made entirely of glass and attached to metal wires passing through and sealed into the glass, as set forth." This application was rejected by the Patent Office, not because it was a palpable repetition of the Edison patent, but for the reason that Crookes's radiometer forestalled the invention. The radiometer referred to is one in which a ring or spiral of platinum is placed in an exhausted globe, and the terminals sealed through the glass. Of course Crookes did not construct it for lighting purposes, but the Patent Office, in refusing Freeman's application, declared:—"It is not deemed material that applicant claims a carbon filament in place of the platinum conductor shown in the reference, the substitution one for the other being within the skill of one versed in matters pertaining to electric lighting, it being old in the art to use carbon conductors for incandescent lamps, as shown in King's English patent."

It seems that this reference was not discovered until after the Edison patent had been issued, but the rejection of Freeman's application plainly manifests how difficult it is for an opinion to be formed on any subject, unless the entire history relating thereto be known; and how often, in consequence, an opinion has to be altered when previously unknown facts are brought to light.

It will not be an easy task for Judge Wallace, in his pending decision, to steer an unbiased way through the complicated mass of evidence arrayed before him, and he will find it all the heavier that, looking at the matter broadly, although Edison's claims may not appear impregnably unassailable, still he will feel convinced that without Mr. Edison incandescent lighting would not so soon have become a commercial success.

ELECTRIC RAILWAY SYSTEMS.

A STATEMENT of more than usual interest to electrical engineers appears in the columns of an American journal devoted to railway and tramway matters. In referring to the greater development in America of electric railways as compared with any other country, our contemporary states: "Recently, there seems to be a much greater interest abroad in the electric 'tramway,' and some firms in this country have received many inquiries in regard to the practical working of such railways in this country. So numerous have they become, that at least one concern here has been led to look into the matter very carefully and to correspond with parties interested. As a result it has come to the conclusion that foreign roads are ready to adopt the system used in this country at once if its advantages are fully explained to them, and it has, therefore, sent a representative to Europe to work up an interest in such matters. This is rather a novel departure, and those who have done so much to make electric railways a success in this country will watch with interest this attempt to extend the same ideas and designs into foreign countries."

This statement is of considerable importance to English and continental firms. That it concerns the United Kingdom equally as well as the continent may safely be assumed from the fact that several gentlemen connected with English tramways have sought information regarding the different systems used and the cost of working them in the United States. One instance was the visit paid to the States some months ago by Mr. W. J. Carruthers-Wain, chairman or managing director of seven English tramways, for the purpose of examining the general working of the lines in that country. It is, of course, only natural that tramway companies should seek for information in the particular country where street electric railways have made so much progress; but the conclusion of the American Company that "foreign roads are ready to adopt the system used in this country at once if its advantages are fully explained to them" is a poor compliment to European systems of electric traction, and if true, it does not imply great faith on the part of our tramway companies in European systems. It must, however, not be forgotten that as far as England, and probably the whole of the United Kingdom, are concerned, the system of overhead conductor so generally adopted in American electric tramway practice is hardly applicable, owing to the Board of Trade regulations, and to the objections of the majority of local authorities to the use of overhead wires. Yet the fact that the representative of an American firm has been sent over to endeavour to introduce American "ideas and designs" brings to mind the questions as to what becomes of European systems, and why the latter cannot be made to answer their purpose in preference to the adoption of transatlantic methods?

During the past four years there have been brought out in the United Kingdom about twelve different systems of electric traction. They have been fully described in the technical journals, they have caused a transitive interchange of compliments between rival inventors, they have been nine day wonders, and then, with the exception of two or three systems being, or about to be, experimented with, they have, as it were, passed out of existence—at least for a time, if not altogether. If financial considerations had not been a *sine quâ non*, doubtless more would have been heard of each system; but most of them remain in precisely the same position as on their inception, that is to say, on paper. Each of the dozen systems may have been faulty to a certain extent; but notwithstanding this, some of them may be considered as well applicable to the working conditions of

English tramways, and the faults, if any, would doubtless be remedied in practical work.

We should, however, imagine, for the reasons above given, that the American overhead system—and very few other methods have either been tried or shown good results in that country—will not find much favour in England, and that English systems are more likely to be eventually adopted. We cannot conclude this article without mentioning the Birmingham Central Tramways Company. The company already possesses a provisional order, authorising it to work its cars generally by electricity, and it is now seeking to get its order confirmed by Act of Parliament. It proposes to lay down an underground system. This is very significant, and the results will be looked forward to with interest.

NOTES ON THE ELECTROLYTIC MANUFACTURE OF ALUMINIUM.

In a paper on the industrial value and manufacture of aluminium recently read before the Liverpool section of the Society of Chemical Industry, Mr. J. H. Dagger gave a great deal of interesting information concerning the chemical and physical properties of this metal, its history, prospects, &c. A comparatively small amount of space was devoted to the electrolytic methods of manufacture; from this section, however, we make the following abstract:—

Mr. Dagger expressed his opinion that, notwithstanding the very great improvement in the mechanical arrangements and the cheapening of sodium by the recent improvements of Castner and others, it is only a question of time when the old chemical methods will be superseded altogether by the newer electrolytic processes for the production of aluminium; even at the present time it is not possible to produce aluminium of equal purity by the use of sodium at anything like equal cost.

Of the electrolytic processes in operation on a commercial scale for the production of aluminium there are, first, the Herault process in operation at the works of the Aluminium Industry Company, Limited, at the Lauffen-Venhausen, on the Rhine Fall, and those of the Société Elcctro-metallurgique at Froges, near Grenoble. In this process the electrolysis is conducted in iron pots or tanks lined with carbon; the pot is raised on insulating supports, and connected with the cable from the dynamo so that the lining forms the negative electrode, or else this is made of a piece of metal, iron or copper, fixed in the bottom of the pot.

The positive electrode is of carbon, and so arranged that it can be lowered or raised in the molten charge.

The first charge is a small quantity of cryolite, which is rapidly melted by the heat generated by the resistance to the current; as soon as it is fluid the current passes, and alumina is fed into the molten flux.

The process is continuous, and the aluminium which accumulates in the bottom of the pot is tapped every twenty-four hours.

The purity of the metal produced varies from 97 to 99 per cent. During the operation the oxygen combines with the carbon of the positive pole producing carbonic oxide, which burns at the vent in the cover to carbonic-acid gas.

At Froges the electric current is supplied by four dynamos each 6,000 ampères, with a voltage of 15, worked by two large turbines of 300 horse-power each.

At Venhausen are two dynamos constructed to develop 14,000 ampères at 30 volts, and a smaller one of 3,000 ampères at 65 volts. The total horse-power of this plant is about 1,500.

In the Hall process, alumina is dissolved in a fused bath of the double fluoride of aluminium and potassium, or of aluminium and sodium. The salts are mixed in a proportion corresponding to the formula—

$$K_2 Al_2 F_6 (Al_2 F_6 . 169 . K F . 116).$$

An excess of the potassium salt will increase the solvent form of the bath, but decrease its fusibility.

A larger quantity of aluminium fluoride renders the bath more fusible, but diminishes the alumina dissolved.

The operation is conducted in iron tanks arranged in series. They are lined with carbon, and form the negative electrodes or cathodes. The positive electrodes or anodes are carbon rods 3 inches diameter, attached by ¾-inch copper rods, and the conductors or leads by means of suitable clamps.

The current of 5,000 ampères and 50 volts in one series, and of 2,000 ampères and 20 volts in the other series, is turned on. The mixtures of fluoride in the tanks or pot is melted by the heat generated by the resistance they offer to the current. In about two hours' time the mixture becomes fluid, and alumina is added. When electrolysis commences, the liberated aluminium sinks to the bottom of the tank, the oxygen going to the positive pole, combining with the carbon and escaping as CO_2.

During the operation the bath is kept covered with fine carbon dust, and on this is placed the powdered alumina. When the voltameter indicates a rising resistance, the attendant stirs in more alumina from the surface of the pot, the carbon dust rises again to the surface, and fresh alumina is placed upon it.

The metal produced is dipped out with cast-iron ladles, any entangled electrolyte being skimmed back into the pot. The operation is a continuous one, and the metal produced is very pure.

The first "run" of metal carries with it all the iron and silicon of the electrolyte, the only remaining source of impurity being the alumina added, and the ash of the carbons which are consumed in the proportion of a little less than weight of carbon to weight of metal produced. The electrical energy expended is calculated at 22 E.H.P. per hour per lb. of aluminium.

The advance of electrical science has given us an increased knowledge of the laws of electrolysis, and the improvement in dynamos and electrical machinery has within the last two years reduced the cost of aluminium from 15s. to 5s. per lb. The following table exhibits the fall in prices since 1855:—

1855	360s. per lb.
1857	103s. „
1860	62s. „
1862 to 1877	20s. „
1888	15s. „
1890 to 1891	5s. „

The Fixation of Nitrogen by Electricity.

IN a recent issue of the REVIEW we devoted some space in our leading columns to the new science (if such it may be termed) of electroculture, and some experimental results were quoted from which it appears that electricity certainly exercises some remarkable influence upon the development of plant life. We now learn that the director of the Meudon station of vegetable chemistry in France has issued a report in which a series of experiments upon the fixation of nitrogen in the soil are described as being, at least in some measure, due to the influence of electricity. During the past season this series of experiments which has long been in progress gave some very affirmative results, tending to confirm the previous conclusions arrived at, namely that the effect of electricity upon the soil is to facilitate the fixation of nitrogen by the soil and by the plants which may be growing in it. As might be surmised such experiments as these are very laborious and costly. They are of far too complicated and expensive a nature to lead to any practical applications in agriculture or horticulture, but they are nevertheless extremely interesting, since they demonstrate the connection of fertility with electricity in the ordinary course of nature. Mons. Berthelot supervised these experiments, and his name is a sufficient guarantee of the thoroughness of the work and of the accuracy of the results. It was found that not only was the gain of nitrogen by the soil very great when the latter was covered with vegetation, but that it was also considerable even when it was kept bare. It is the atmospheric nitrogen, which thus becomes fixed in the soil under the influence of electricity.

An Explosive Gold Compound Recently Obtained in Electrolysis.

THE experiences of one, W. Hampe, in making some electrolytic researches, exemplify the inconvenience, to say nothing of the danger, of exploring the regions of the unknown. A recent issue of the *Chemiker Zeitung* contains an account of Hampe's experiments in the production of a hydrated oxide of gold by electrolysis (*vide* vol. xiv., p. 1778). A fine sheet of gold was used as the positive electrode in a sulphuric acid or nitric acid solution. When the current passed, the sheet of gold rapidly changed its colour to brown, and finally a reddish-brown powder began to accumulate upon the bottom of the electrolysing bath. This powder turned out to be a hydrated oxide of gold, and was probably formed by the oxidising action of the electrolytically-evolved oxygen. So far no inconvenience arose; when, however, Herr Hampe dried the compound over sulphuric acid in order to expel all moisture and then began to heat it, the substance exploded violently, being of a very unstable character. We should advise any of our readers who may be experimenting with unknown substances, to perform such experiments as these with very small quantities. Moreover, the investigator should carefully consider what is *likely* to happen, and should take precautions if the substance is calculated to be unstable.

Glasgow Electric Lighting.

SINCE our article entitled the "Modern Oracle" was published, we have been favoured with a copy of the Glasgow Corporation Gas Minutes, to which are attached the three reports to which we alluded. The minutes are marked *for private use only*. A perusal of the minutes obliges us to modify the statement about Sir William Thomson's report, which consists, we find, of direct answers to questions put to him by the Committee, referring to the limited compulsory area only, but embodying some useful advice, together with a warning as to future possible claims for royalty on usage of low tension mains. The language used is also perfectly plain, and cannot be made to bear two interpretations. We begin to think that the vehement and indignant outbursts in a portion of the Glasgow press are merely political moves to prevent Mr. Crompton obtaining a contract for his company, whereby much credit may be cheaply obtained on the score of patriotism.

The Corporation Consulting Engineer Question.

AT the adjourned meeting of the York City Council, on Monday evening, the Streets and Buildings Committee discussed the question of the electric lighting project. Mr. Wragge put various questions in reference to Mr. Crompton, the consulting electrical engineer for York, and the Chairman, in reply, said that the object of consulting Mr. Crompton was to ascertain the most efficient system of electric lighting for the compulsory area and the entire city. Mr. Crompton was interested in electric lighting, but he promised that the company with which he was connected should be altogether outside any competition for the work. Independent of the fact that Mr. Crompton was a York man, the committee was informed that he was the best man. The committee had the names of three other gentlemen before them when Mr. Crompton was selected. Mr. Wragge submitted that it was most undesirable to call in any gentleman to act in that capacity who was himself interested in a particular system of electric lighting. He then went on to quote an article in the ELECTRICAL REVIEW, of June 5th, animadverting on Mr. Crompton's appointment to a similar position in Glasgow, and deprecating on public grounds the selection of engineer contractors as advisers. Proceeding, the speaker argued that if Mr. Crompton recommended at York any system other than the one with which he was identified he could not consistently after that advocate the adoption of his system anywhere else. One of the members admitted that many of his colleagues were entering upon a matter of which they had no knowlege, and the discussion ended by the Chairman expressing his belief that the opinions expressed by Mr. Wragge and others would have due weight. Mr. Wragge, however, has not had the last word; he is going to say more on the subject of Mr. Crompton's appointment on a future occasion.

The City Lighting.

NONSENSE was the order of the day amongst certain members of the Commission of Sewers on Tuesday last when discussing the City lighting. Mr. Sayer presented the report of the Streets Committee, which contained a reference to the proposed transfer of the undertakings in regard to the City electric lighting to a new company, to be formed under the title of "The City of London Electric Lighting Company." The committee recommended that this transfer should take place provided the Commissioners were satisfied with the particulars. Mr. Sayer said it was always understood that the two companies would either have to borrow a large sum of money or form a syndicate, and he believed that the greatest electrical firms in London were connected with this company. Mr. C. T. Harris moved an amendment to the effect that the Commissioners were unable to approve of the proposed transfer of the provisional orders, and that further information as to the value of works, buildings, and plant, &c., should be provided, and that the Commissioners, in the interest of the consumers, strongly objected to any money being paid as purchase-money. After wasting much time in asking irrelevant questions, in making insinuations and in the indulgence of mutual recrimination, the amendment, which should never have been brought forward, was lost.

TELEGRAPHS IN THE FIELD.

ROYAL ENGINEERS—TELEGRAPH BATTALION—FIRST DIVISION.

IT has been the custom of late years for the First Division Telegraph Battalion to be sent out camping for a period of six weeks during the summer, in order to give opportunities for training the men in field duties. This year the exercise has been divided into two parts, the second of which is intended to be in connection with the infantry manœuvres proposed for the autumn. For the first part a programme was fixed, based upon the idea of testing at what rate a telegraph line (bare wire on light field poles) could be erected, under the supposition that it was to accompany a forced march. For that purpose the route chosen was from Aldershot to Chevening, near Sevenoaks, the distance being 48 miles, and the work was carried out as follows:—Eight working detachments were formed, each consisting of

1 waggon carrying 6 miles of air line.
10 dismounted men.
1 mounted non-commissioned officer.
6 draught horses and 3 drivers.

Two detachments formed a section, and each of the four sections was under the command of a subaltern officer; a portion of the distance was told off to each, with an order to erect the line and march to camp at Chevening as rapidly as possible, a prize being offered to the first detachment in. In awarding the prize, credit was to be given for good work on the line, and marks to be deducted for bad work or for injury to horse or man.

All the detachments started together at 9.30 a.m. on May 25th, and at 3.30 p.m. on the following day telegraphic communication was established between Aldershot and Chevening Camp. The first detachment arrived at 12.30 p.m. on the the 26th, but was not awarded the prize, on account of some slight galls to the horses, and from the fact that a detachment arriving at 2.30 p.m. had done better work, and brought in men and horses in perfect condition. The detachments had bivouacked *en route* for about five hours during the night, with the exception of No. 1, which had worked in daylight and marched all night. From the result, it is considered that the men and horses would have been equal to another 20 miles before nightfall on the 26th, so that 70 miles of air line would probably be the utmost that could be erected by such means in 24 hours.

On May 27th the line was continued from Chevening towards Chatham, and joined up with a line being erected from Chatham by Major Bagnold.

The material used for the line was what is known as 3/18 galvanised steel strand wire, attached to ebonite insulators, fixed to 13-feet fir or bamboo poles. Communication was first opened by using vibrating sounders or "buzzers," afterwards changed to single current instruments of the Post Office pony sounder pattern, fitted with Siemens's relays.

The headquarter camp of the troop was at Chevening, where for some time a translator was used on the line. All the instruments worked well, though for the translating set it was found that the Field Service battery was not applicable, and a new form of that article is much required.

On one day duplex was worked with very fair result, considering the bad insulation caused by tree contacts, which were unavoidable. Telephones were switched in every evening on completion of the day's work, and communication kept up by them from the officer's mess to Chatham and also to the Aldershot mess. The instruments used were the Gower-Bell, Ader, and Major Bagnold's combined Ader with Hunnings transmitter. They all worked well, and great advantage was found in using the new magneto instead of the battery call bell. On one occasion, when a particular station had not a magneto to reply to one at the far station, Major Bagnold, who was present, joined up a double current key which answered the purpose admirably.

It so happened that a large ball was given by the R.E. officers at Chatham on the night of June 6th, and a telephonic circuit was arranged between the ball room and the Aldershot mess, whereby the officers at the latter were enabled to hold converse with their friends.

The line was dismantled on June 15th and 16th, and the troop marched back to Aldershot in three days.

In judging of the work done, it must be remembered that England is perhaps the most difficult country in the world for running a field line, owing to the enclosed nature of the country, the numerous angles and crossings along the roads, and the individual rights which have to be respected in peace time. The result, however, possibly gives the best record of speed which has hitherto been obtained in erecting a telegraph line.

The working of the traffic on field lines on service will, it is believed, have to be entirely carried out by men trained under the General Post Office, for no other men could satisfactorily cope with the immense amount of messages which emanate from the officials of a British army.

A ROUGH-AND-READY DYNAMOMETER FOR SMALL MOTORS.*

BY JOHN HOSKIN.

I HAVE been requested to bring to your notice this evening a friction-brake dynamometer that is by no means new, but is one that is deserving of being more widely known by electricians than appears to be the case.

Like the well-known Prony brake it acts as an absorption dynamometer; and without detracting from the acknowledged value of this instrument, especially for testing the value of large prime movers, yet we need something more portable, more convenient to use, in the very numerous cases where it is desirable to test the efficiency of small motors.

We need a rough-and-ready instrument that is portable, inexpensive, readily used, and at the same time reliable.

This we find in a friction-brake dynamometer, one of the many modifications of those illustrated by Mr. William Worby Beaumont, in his paper on friction-brake dynamometers, read before the Institution of Civil Engineers in London, November 13th, 1888, and published in 1889 in the "Proceedings" of the Institution.

Its construction requires only the use of a leather belt with a spring balance attached to one end, and a suitable weight at the other. The belt is to be thrown over the belt pulley of the motor, the spring balance is fastened to the floor base, or support of the motor to be tested, and the weighted end hangs pendant on the side of the pulley which, when in motion, will tend to lift the weight. When the motor is at rest, the strain of the weight should be read off on the spring balance. This reading we will call W. When the current is switched on, and the motor runs at speed, the spring balance should again be read off, since the friction of the pulley on the belt will have a tendency to raise the weight; this reading we will call W′. The difference between W and W′ in pounds, multiplied by the circumference of the pulley in feet (including one-half the belt thickness on each side), and this by the number of pulley revolutions per minute will give the foot-pounds of mechanical energy, which can be compared with the electrical energy required to produce it, in the usual manner.

Thus, in a few minutes, with the aid of a speed counter or tachometer, a voltmeter and an ammeter, the efficiency of a motor can be determined, and its ability to do a desired amount of work ascertained at once, instead of being left to guesswork, as would often be the case if more bulky or elaborate apparatus were needed.

It should not be imagined from these remarks that this form of dynamometer is applicable to small motors only; but it is evident that for testing larger machines where many horse-power have to be measured, the apparatus needs more elaboration, especially in the use of friction blocks under the belt or pulley strap, their lubrication, and the use of a dash-pot to steady the brake when the motive power is irregular.

But I need not enlarge on this, except to say that in these particulars, whether using steel strap, or leather belt with

* Read at the meeting of the Electrical Section, Franklin Institute, May 5th, 1891.

friction blocks, or rope friction, the same care is needed as in the Prony brake to obtain correct readings.

Before concluding, I submit to your consideration the value of the Waldron rotary pump for use as a dynamometer, although I have never heard that it has been applied to that purpose. In examining one of these engines recently for other purposes, it occurred to me that it would serve as an excellent dynamometer.

This pump is operated by rotary piston blades, working in a chamber, without leakage, and with but small friction, the amount of which can readily be ascertained and calculated for use as a "constant." Its capacity per revolution, and the number of revolutions being known, as also the pressure against which it works, which can be regulated by a pressure gauge, the foot-pounds of work are at once arrived at.

This method of measurement will correctly register the work done, although the speed may be irregular; and its results can be made more accurate than that of the friction dynamometer, because not subject to the irregularities arising from differences in lubricants, temperature, &c., which makes it necessary to use adjusting screws in most forms of friction-brake dynamometers.

THE ELECTRIC LIGHTING OF BUDAPEST.

[FROM OUR OWN CORRESPONDENT.]

AFTER an interval of more than a year, the question of the electric lighting of Budapest has again taken a step forward, although a small one. Conditions have at last been fixed under which a limited competition is to be invited. Proposals are to be requested from the firms Ganz and Co., of Budapest; Siemens and Halske, of Berlin; Victor Popp, of Paris; and the Budapest Gas Company. Tenders are to be given in on the basis of the following interrogations:—

1. What terms of a concession does the projector wish? or, in other words, when is the conductive net to pass free into the hands of the community?

2. When and under what conditions can the entire conductive net, with the accessory manufacturing plant, be bought up for the community?

3. What maximum price does the projector propose for a carcel-hour furnished by a glow-lamp? and what maximum price for a volta arc light?

4. What maximum price does the projector lay down for a quantity of electric energy corresponding to a horse-power hour?

5. What discount is the projector prepared to allow for the lamps serving to light the streets?

6. What advantages will be conceded to large consumers? and what percentage of the gross income will be conceded in favour of the city?

7. What sum will be asked for the hire of the electricity-meters?

8. How large is to be the net for electric lighting and for the transfer of energy at the commencement of the working, and on what scale is it to be enlarged yearly if electric light is required?

9. What electric current, alternating or continuous, is to be applied?

10. Where does the projector propose to erect his installation for generating the current, and to what distance can electric energy be supplied if a continuous current is used?

11. Within what limit of time after the grant of the concession is the projector bound to commence operations?

12. When is the projector bound after obtaining the concession to furnish electricity for lighting or for power along the first part of the conductive net?

From the schedule of conditions, involving for the most part technical details, we extract the following points:—

The undertaking must have its seat at Budapest.

Within the limits of the maximum price, the projector can fix his scale of charges at pleasure. After the lapse of five years the authorities can reduce the maximum price, if the revenue of the undertaking is increased by improvements in the manner of production. The reduction is determined by a committee of four, the resolution of which becomes valid only if accepted at a general meeting of the municipal committee. Two members of the committee of four are nominated by the city and two by the undertaking. This arbitration committee selects outside its own body an umpire, but if there is no agreement as to the person to be selected, the Board of Works nominates an umpire.

The projector has to pay for the use of municipal land a rent of 10 florins per kilometre. A percentage is also to be paid, which is to be offered by the projector.

The security required is 10,000 florins for the first installation, and further 1,000 florins for each 500 metres of the length of the net.

On these interrogations, and on the accompanying conditions for tenders, the metropolitan "Director of Buildings" (an official somewhat approximating to the Dean of Guild in a Scottish Corporation), has issued a report to the authorities professing to discuss the question of the electric lighting of Budapest, and characterised by the almost incredible superficiality with which so important a question is treated. It will be thought scarcely credible that the engineer's office of the Hungarian capital could issue such a report as the outcome of prolonged—needlessly prolonged—studies. I forward you the following extract from this document:—

With reference to the essence of the question, we must remark that there have arisen three methods of producing electric light and power in towns. On their respective values opinions differ, whence different principles have been applied in the cities of the Continent. In many cities several of these methods of application are in use simultaneously.

The following three kinds are most commonly employed:—Electric lighting and transmission of power by means of a continuous current; electric lighting and transmission of power by means of the alternating current; and in connection with electric lighting and transmission of power the production of cold and ventilation with the help of compressed air.*

The first of these methods of production is of a rather earlier date than the others.

The currents in this case have not a high tension, which is an advantage according to the adherents of this system. On the other hand, currents which certainly possess a certain tension are conveyed directly into the houses, and according as this has a certain limit, even weak currents may be dangerous.

Further, these currents can be utilised only at small distances, *e.g.*, in Vienna at 800 metres, and even here, for the sake of uniform working, they have to be supplemented with accumulators. These accumulators require, however, complicated arrangements, and make the work cumbrous.

In consequence of the circumstance that the current can be used only at relatively small distances, several works are necessary for lighting up a large area, which again involves the disadvantage, that in densely peopled districts, works using 2,000 to 3,000 horse-power are necessary, *e.g.*, in Vienna, where there exist two such works, the larger belonging to Siemens and Halske, and elsewhere the localisation of such works in the interior of cities is, to say the least, not to be desired.

Besides, the escape of the condensing water is a burden for the sewers (!)

Notwithstanding, such works exist in large cities, *e.g.*, Berlin, Vienna and Hamburg, and in part also in Paris, and act successfully.

According to the second method of production, *i.e.*, by means of the alternating current, illumination and transmission of power, as it may be required, can be supplied by means of large works situate outside of the town, as this is done in numerous large or small towns, even to very great distances, in England and on the Continent, as in Vienna, by the International Electricity Company (Ganz & Co.), as also in Milan, Rome and elsewhere, with full success, and as it is about to be introduced at Cologne and Frankfort-on-Main.

An objection to this system, according to its opponents, is the high tension of the current, which, however, at all ramifications for illuminating purposes, can be so reduced by means of transformers (which are here used successfully) that it no longer involves any kind of danger.

A current of high tension circulates only in the cables

* It may be noted that the great obstacle to ventilation is the lack of a continuous supply of *warm* air.

which are so thoroughly protected and enclosed that to my knowledge no accident has hitherto been occasioned on the Continent.

I admit, on my part, the advantages of this method of production, and if suitable precautions are taken, I entertain no hesitation on the ground of safety.

Both methods can be, and are used, for the transmission of power, *e.g.*, with full success at the port of Fiumane for working elevators.

The third method of production acts with the aid of dynamos driven by compressed air.

Compressed air can likewise be conveyed to great distances from stations far removed from the more populous quarters of towns.

With this compressed air dynamos are driven both at the works and within the town, but without smoke and soot, and boilers capable of explosion.

The illumination is here also effected by means of cables.

A PHOTOGRAPHIC STUDY OF THE ELECTRIC ARC. BASED UPON EXPERIMENTS MADE BY MR. J. C. McMYNN.*

BY EDWARD L. NICHOLS.

AT the last general meeting of the Institute, Mr. Louis B. Marks read a paper on the electric arc, which dealt with the performance of commercial lamps in the continuous current circuit. The present paper is a preliminary report of a similar line of work now being carried on under the writer's direction by Mr. J. C. McMynn, the subject of the investigation being the alternating current arc. When the research in question is completed, Mr. McMynn will publish the results in full; but, since his report may not be ready for several months, it seemed desirable that I should lay before the Institute at this meeting certain points which have already been established.

The alternating current arc and the continuous current arc afford two entirely distinct fields of investigation. Candle-power, distribution of light, quality of light, temperature, efficiency, resistance, electromotive force necessary to maintain the arc, performance of the carbons under varying conditions; all of these are questions concerning which we have abundance of experimental data, so far as the continuous current arc is concerned. In the case of the alternating arc, however, these and many other points are still to be determined.

The arc lamp, fed by alternating currents, invariably hums and sings. The note, which is not to be mistaken for the hissing which we hear from continuous current lamps that are burning under improper conditions, possesses a definite pitch, determined by the alternation of the dynamo. That the note is not due to the mechanism of the lamp is itself readily shown. The Jablochkoff candle, which is devoid of all mechanism, sings as merrily as the lamp with solenoid regulator; any form of hand lamp will do the same. I do not remember having seen any definite statement concerning the source of this humming noise, nor any satisfactory discussion of the question. My attention was first brought to the very obvious explanation of the phenomenon by the study of certain curves of electromotive force, obtained by Messrs. Archbold and Teeple, in the course of an investigation of the alternating discharge between a ball and point.† These curves have recently been published. I reproduce one of them for the purpose of elucidation.‡ This curve was obtained by the well-known method of instantaneous contacts. The circuit under investigation was the high-tension secondary of an induction coil, actuated by an alternating current dynamo, the E.M.F. of which followed the law of sines closely. In the circuit were placed a ball and point, the air space between them being such that the discharge would take place in one direction only, from ball to point. It was established by the use of a revolving mirror that an arc existed only during that part of each cycle represented by the horizontal portion of the curve. [*a* — *b*, fig. 1.] Shortly after this curve had been obtained, the curves of Messrs. Tobey and Walbridge, illustrating the performance of the Stanley arc lighting dynamo appeared.* It will be remembered by those who

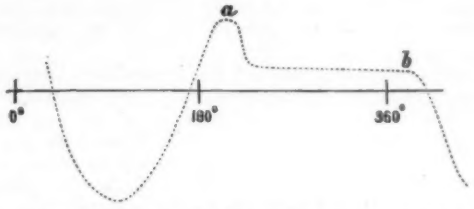


FIG. 1.—FROM ARCHBOLD AND TEEPLE'S THESIS ON THE "BALL AND POINT" EFFECT.

heard their paper read before the Institute that this machine, which gave very nearly the sine curve of E.M.F. when working through non-inductive resistance, showed curves very widely removed from that form when arc lamps were in the outer circuit.

Fig. 2 contains the curve of the arc lighting machine when five lamps were in circuit. The relation of this curve to those obtained with the ball and point is evident. Here, also, the variation of the curve from sinusoidal form is to be ascribed to the periodic formation and breaking down of the arc,

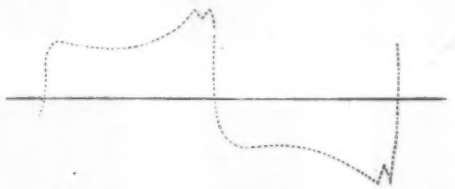


FIG. 2.—FROM TOBEY AND WALBRIDGE'S PAPER OF THE STANLEY ARC LIGHTING MACHINE.

which happens twice in every complete cycle, instead of once, as in the case of the "one-way" discharge of the ball and point phenomenon.

After studying these curves, it seemed to me unquestionable that the humming of the alternating arc is due to the rapid periodic extinction and re-establishment of the discharge, the effect being similar to that observed in singing flames. When, some months later, opportunity was found of viewing the image of the arc of an alternating current lamp in the revolving mirror, I was prepared to witness the extinction of the arc during a definite part of each alternation. I do not know whether any member of the Institute has tried this simple experiment. I have seen no description of it anywhere, although Wiedemann mentions the application of the revolving mirror to the study of the continuous current arc,† and Joubert‡ (1880) makes brief mention of a very ingenious application of the plenakistiscope to the study of the changes to which the alternating arc is subject during each period. When such a mirror, mounted upon a vertical axis, is set up at a convenient distance from the lamp, the images of the white-hot tips of the upper and lower carbons are drawn out by the revolution of the mirror into uniform, parallel bands, extending quite across the field of view. The intervening narrow strip, much darker, is the image of the arc itself. This region, however, is not uniform. It consists of alternate patches of purple and black, which mark the intervals during which the arc exists and is extinct.

Mr. McMynn's first step in the investigation which it is my purpose to discuss in this paper was to photograph the arc under conditions which would bring out this pheno-

* A paper read before the American Institute of Electrical Engineers, May 20th, 1891.

† See Archbold and Teeple; Thesis in MS., Library of Cornell University, 1889.

‡ See "The Alternating Electric Arc between a Ball and Point."—*American Journal of Science*, Vol. 41, p. 1.

* Tobey and Walbridge: *Transactions*, vol. vii., p. 367.

† Wiedemann: *Elektricitat*, iv., p. 855.

‡ Joubert: *Journal de Physique*, vol. ix., p. 360.

menon. A camera with long bellows was set up near the lamp, the distances from plate to lens and from lens to lamp being such as to give a somewhat enlarged image of the arc. In the focal plane an opaque screen was mounted, which contained an opening just large enough to receive the image of the carbon points. The apparatus having been adjusted, a sensitive plate was driven past the aperture at high speed. The photographic image differed from that observed in the revolving mirror chiefly in the relative brightness of the arc proper, and of the incandescent carbon of the points. To the eye, the latter is the dominant feature; whereas the *actinic* image of the arc far exceeded in intensity that of the carbons.

These photographs establish the intermittent character of the alternating arc beyond question. They also exhibit in a new light many interesting properties of the arc, some of which are already well known, while others have not been noted. Of the many negatives already obtained, a few characteristic forms are given in the accompanying plates.

Figs. 3, 4, 5 and 6 show the results obtained with plates moving in a horizontal direction, at right angles with the axis of the carbons of the lamp. Fig 3 is an enlargement of one of the first negatives taken. The speed of the plate was moderate, the size of the image smaller than the arc itself. The plate contains but little detail. The carbons do not appear at all in the photograph, which shows little besides the periodic interruption of the arc. In later negatives the size of the image was greatly increased and the plate was driven much more rapidly through the field. In many instances two or more successive exposures were made upon the same negative. Inspection of figs. 4, 5, and 6 shows that the greatest intensity resides neither in the arc itself nor on the incandescent carbons, but in a narrow region just at the ends of the arc. In this region, which, doubtless, is where the so-called "contact resistance" of the arc occurs, the illumination is sometimes intermittent, as in fig. 4; sometimes nearly uniform, as in figs. 5 and 6. The relative width of the intervals of darkness and of light is also seen to vary greatly under conditions not yet determined. Fig. 6 represents the highest rate of speed given to the plate in any of these exposures. The image of a single alternation was, in this case, extended almost across the plate. No new feature were brought to light, however, by this process of magnification.

Figs. 7, 8, 9, 10, 11 and 12 were obtained by driving the plate vertically through the field, parallel to the carbons. An unlooked for feature of all these plates was the oscillation of the arc from right to left in synchronism with the alternation period. Mr. McMynn suspected this vibration to be due to the action of the earth's magnetic field.* He was able to verify his view by comparing photographs made with the camera placed with its optical axis in the meridian with others in which the arc was viewed from the east or west. The disturbance was more marked in the former position, and disappeared almost entirely from negatives taken in the latter. This point is well illustrated by fig. 8 (A and B), which shows the image obtained from the north and from the east. The lamp in this case was supplied with cylindrical carbons. All the other photographs represent the arc between flat carbons. In a strong field, produced by placing the arc nearly between the poles of a horseshoe magnet, the lines of force being perpendicular to the axis of the lamp, and parallel to that of the camera, the vibratory effect was much increased. [See fig. 7 (B).] The bearded appearance of the arc, figs. 9, 10 and 11, is common to all the negatives taken while the arc was in the strong field. The spines are supposed to be the paths of very minute and highly incandescent particles expelled from the arc at a considerable velocity under the action of the magnetic forces. A continuous current arc, also in a strong field, the conditions being as nearly as possible those under which figs. 9, 10 and 11 were taken, gave a negative of which fig. 12 is a very imperfect representation. The arc was flaming, and it will be seen that while the path of the arc itself is an unbroken, straight trace, the flames, which show themselves to the right and left hands, are irregularly intermittent. The negative shows, moreover, that the flame to the right hand, in the figure, is finely striated, reminding one of the image of a hissing, sensitive gas flame as the

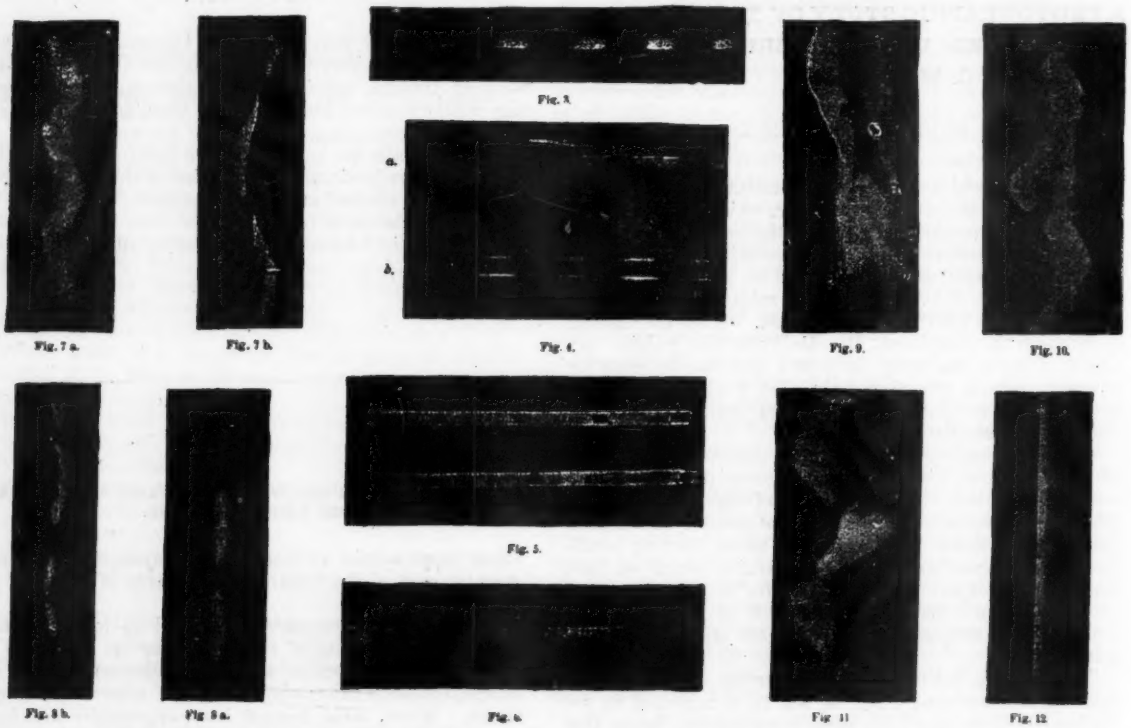


FIG. 3.—Alternating arc. [Movement of plate horizontal.] FIG. 4.—Alternating arc. *a*. Short arc (43 volts) *b*. Long arc (58 volts). [Movement of plate horizontal.] FIG. 5.—Alternating arc. [Movement of plate horizontal.] FIG. 6.—Alternating arc. [Movement of plate horizontal.] High speed. FIG. 7.—Alternating arc. [Movement of plate vertical.] *a*. Showing oscillations due to earth's field. *b*. Showing oscillations in a stronger field. FIG. 8.—Alternating arc between cylindrical carbons. [Movement of plate vertical.] *a*. Arc viewed from north showing oscillations due to earth's field. *b*. Arc viewed from west. FIG. 9.—Alternating arc. [Movement of plate vertical; arc in strong magnetic field.] FIG. 10.—Alternating arc. [Mbvement of plate vertical; arc in strong magnetic field.] FIG. 11.—Alternating arc. [Movement of plate vertical; arc in a strong magnetic field.] FIG. 12.—Continuous current arc. [Movement of plate vertical; arc in a strong magnetic field; arc flaming.]

* It should be noted that Casselmann, as long ago as 1844, described the deflecting action of the earth's field upon the continuous current arc. (See *Poggendorff's Annalen*, 63, p. 588.)

latter appears in the revolving mirror. This vibration, which must represent a pitch of several thousand vibrations per second, is in all probability the cause of the hissing of the arc.

In this brief discussion I have left untouched many points which will suggest themselves to those who study Mr. McMynn's photographs. The interpretation of many of the features of these plates is at present rather obscure; but it is hoped that experiments now in progress will add something to our present knowledge of the phenomena connected with the alternating electric arc.

DISCUSSION.

Prof. ELIHU THOMSON: I would suggest that a very good thing to try in this connection would be to actually produce, if possible, an arc with a sine curve wave—that is, hold the sine curve wave by a large resistance in the circuit or by self-induction, and then investigate the characters in a similar manner. Of course the arc would probably deform it somewhat. I can readily understand that the reason for the curve of current taking the form it does, is that the resistance of the arc falling with the increase of current, naturally the moment it begins falls to a point only limited perhaps by the capacity of the apparatus feeding the arc—that is, the vertical line shown in the curve of current representing the arc shows that the moment the arc starts there is practically no limit to the current which might pass through that arc if the electromotive force was not extraordinary. That is, under constant potential there would be no limit that would naturally be expected. There is one matter in connection with the photograph that I might mention here. I do not think you can argue absolutely that the current stops, or that there is an absolute cessation of the arc because the photograph doesn't show it. It may be that the current flowing is so small as not to give actinic luminosity to the stream, but it is also well known that a photographic plate to develop strongly requires a certain amount of actinic work done on it—that is, taking the ordinary case of a sensitometer used to determine the sensitiveness of the plate. If you take such a sensitometer, consisting of a number of porcelain squares, and expose it to light, you will find a development up to a certain number, and after that a quick change—that is, there is a certain quick development after a certain amount of exposure, so that the plate may be resistant up to a certain point and give way when the light has reached the plate in a certain amount. It may be, as Mr. Mailloux suggests, a sort of coercive force in the plate. I am reminded of the photograph exhibited some few years ago of electric sparks. Some cases of the photography of a spark give a reversed image—that is, giving a dark image on a comparatively light ground. There we have the case of another action of the photographic plate, which is solarisation—that is, too much light will cause sensitiveness also. Some of the results seen here may admit of such an interpretation. I notice in the lower part of fig. 5 what seem to be little dark spaces in between the wider black spaces, and in fig. 6* that seems rather startingly shown; and the question there arises whether that is really due to the drop in luminosity, or whether it is due to solarisation; but as the curve of current shows a depth there it probably is due to the drop in luminosity and not to solarisation. Still that would be a matter to be taken into account in all these cases. The results are certainly very interesting, and the field of work is one which is certainly of great interest to those connected with the application of arcs in practice. Results certainly show that the acuteness or sharpness of the sound—the noisiness of the arc—is increased by the fact that there is a tendency to absolute break. We can readily imagine that if the curve of the current was a sine curve, that the note given out would be a very smooth, musical note, but in the case before us, where the results seem to indicate almost an absolute break in the current, we can understand that it is like a set of lashings of the air, and the noise produced would be sharper and harsher to the ear in consequence. This nuisance of harshness might probably be ameliorated by the suggestions that I made at the start, by actually forcing the sine curve current through, keeping it as near as possible the sine curve current.

* See *The Electrical World*, May 30th, 1891.

Dr. OTTO A. MOSES: There is one feature of the arc that I do not recollect to have seen touched upon by any of those who have studied the subject, which I think is here illustrated and perhaps elucidated. The material transmitted, whether with a continuous or an alternating current, from one pole to the other is a volatilised hydrocarbon gas. In that case we have this phenomenon—a column of gas rising or falling, according to the direction of the current, surrounded by an envelope of oxygen. That is an element not to be neglected. We have, of course, in the oxidation of the hydrocarbon a cause of luminosity independent of the current passing. The interior of such a column of gas would naturally present, through photographic influence, a dark spot.

Prof. E. L. NICHOLS: The photographs in this case were secondary to observations with the revolving mirror. I should hardly have ventured to interpret photographs alone, because I am well aware of the difficulty of so doing. But a view of the arc in the revolving mirror makes it evident visually. All that can be said is that the mass is so very small that it doesn't take an appreciable time to cool below the point at which it gives out light. That is the meaning of extinction in the way I used it.

Mr. CARL HERING: I would like to ask in regard to fig. 12, whether it was placed east or west or north or south in the magnetic field, and, at the same time, whether it was a battery current or a pulsating current.

Prof. E. L. NICHOLS: Fig. 12 represents a continuous current arc in the same strong magnetic field which was used in figs. 9, 10 and 11, so that that flaming on the side shows that there were two elements moving in one direction and one in the other, and that it was placed east and west, and was under the influence of an artificial field. The lines of force might be considered as parallel to the paper and horizontal. It was a current from an Edison machine—a single lamp with resistance in series sufficient to cause it to regulate properly—probably rather a smooth current.

AN ELECTROLYTIC PROCESS FOR OBTAINING SILVER AND COPPER DIRECT FROM THE ORES.

WHEREVER fuel is dear it is certain that the new electrolytic processes for the extraction of metals from their ores will attract considerable attention. In Spain and Chili, for instance, where much copper ore is to be found, most kinds of fuel are far from being cheap, and in such countries the electrolytic processes might well be taken up with advantage.

A recent issue of *Dingler's Polytechnisches Journal* contains a paper on the Höpfner process of extracting silver and copper from their respective ores by means of electrolysis.

Höpfner uses a bath which is separated into compartments by means of diaphragms; generally there are two such compartments, and in one are placed electrolytically insoluble anodes, and in the other copper cathodes.

A double salt of cuprous chloride and a halogen salt circulates round the anodes, and a similar solution round the cathodes. On the copper spongy copper is deposited at a rate of 2·36 grammes per ampère-hour, and this is double the quantity of metal deposited when a cupric salt is made use of.

If cuprous chloride were not present, then at the anode some free chlorine gas would form, and it would be necessary to have available an electromotive force of 1·8 volt. But in this arrangement the liberated chlorine at once unites with the cuprous chloride, converting it into cupric chloride, equivalent to 1 volt. Hence electrolysis can take place with an electromotive force of 0·8 volt, thus—

$$\text{E.M.F.} = 1{\cdot}8 - 1{\cdot}0 = 0{\cdot}8.$$

Theoretically, the electrolysis commences with the consumption of 0·13 volt. This can be deduced by determining the heat of formation of cuprous and cupric chlorides.

As the liquid flows past the cathode it gradually parts with its copper, and is available for use again; but the copper

is, of course, now present as cupric chloride instead of cuprous chloride, and the latter is made to leave the bath in a continuous stream. This solution is employed in an industrial way for extracting the metal from powdered copper and silver ores, special "leaching" vessels being employed.

If the ores are sulphides, then the following reaction takes place, viz. :—

$$Cu\ Cl_2 + Cu\ S = S + Cu_2\ Cl_2.$$

The solution of the cuprous chloride is regenerated, but it is twice as strong now as before, and so it is necessary to dilute it in order to bring it back to its normal condition of concentration; this is effected by mixing it with the waste liquors that come away from the cathodes.

The process, as will readily be seen, may be worked continuously, for the regenerated solution can be used over again as before.

This process would work admirably were it not for the influence of certain natural drawbacks. Sometimes there is present in the ores small quantities—perhaps only traces—of such substances as iron, arsenic, bismuth, antimony, &c., and these will pass into solution instead of the copper. The presence of iron is especially objectionable, since it very sensibly retards the solvent action of the copper salt upon the ore that is being treated.

These adventitious impurities must not be allowed to deposit along with the copper. Fortunately, however, it is by no means difficult to eliminate them, for they can be precipitated by means of copper oxide, and so easily separated off.

In working with silver and copper ores, the former metal, if it be present, is first deposited, and the resulting copper is obtained in a chemically pure condition.

The advantages which are claimed to pertain to the use of Höpfner's process are the following :—

1. By electrolysing cuprous chloride solution, the amount of copper deposited is twice as much as that which would be thrown down from a solution of sulphate of copper when the same intensity of current is employed.

2. Solutions free from iron can be made use of because the alkaline and alkaline-earth chlorides possess a great solvent action upon cuprous chloride. In this respect also this process is superior to the copper-sulphate process.

3. The most impure ores may be used, yet pure copper may be obtained, and from silver-bearing ores the silver may be deposited at the same time.

4. Forty-four kilogrammes of copper may be obtained by this method in twenty-four hours with an expenditure of one horse-power.

5. When reckoning the work of the pumps and the mechanical agitation of the liquor at *one-quarter*, and the electrodynamic power at *three-quarters*, of the total work necessary to the operation, then with an expenditure of 30 kilogrammes of coal 33 kilogrammes of copper may be obtained.

An examination of the figures just quoted will show that the results obtained by the Höpfner process of electrolysing ores are higher than any which have hitherto been reached—so high, indeed, that the poorest ores may be profitably worked.

ROPE GEAR FOR ELECTRIC LIGHT WORK.

By W. H. BOOTH and FRANK B. LEA.

It would be rather difficult for an electrician to state just exactly the reasons that during the past 20 years or so have led to the extensive—if not exclusive—adoption of rope gearing in the great textile factories scattered throughout the north of England. Perhaps one important consideration has been that it is practically easier in these districts to use well known material such as cotton; besides which, rope gearing is so peculiarly noiseless, when properly at work, that on this account alone it might be well worth adoption, in view of the whirl and clatter incessantly arising from the looms and frames. Every mechanic is aware that noise in machinery means loss of power, and hence he is always ready to avoid it where possible—quite apart from æsthetic reasons, or a regard for the tympana of work people. We shall see later on, however, the reasons for adopting systems of rope gearing, which are by this time familiar enough to those who have had experience of engineering work in the cotton districts. Year in, year out, the huge and heavy grooved flywheel may be seen revolving in what should really be called an engine "hall" rather than "house," with a score or so of cotton ropes flying round it, swiftly and noiselessly, away up to each floor of the mill.

Although, therefore, it would be very natural that engineers who have been used to rope gearing should employ it wherever possible, and especially for transmitting large powers with an increase of speed, yet it is still a considerable novelty in connection with electric light work; for even when dynamos are not coupled direct to high speed engines, there are plenty of electrical engineers who swear that nothing is equal to leather for ease and regularity of driving.

The great advantage to be derived from belt or rope gear lies, of course, in the engine economy, for in spite of the excellent results obtained in steam motors of the Willans or other high speed direct acting types, these cannot hold comparison for ultimate efficiency with the powerful and larger horizontal engines fitted with condensers, sensitive governors, ultra-perfect valve gear, and running at moderate velocities as regards revolutions, but at fairly quick piston speeds.

In deciding, therefore, whether to adopt rope driving, or couple the dynamos direct to the engine, the main consideration is one that affects the engine efficiency alone, rather than the way in which its power is transmitted; and comparison, therefore, will be instituted principally between what may be called the *continuous* belt system and the *interrupted* belt (or rope) system, since, after all, a series of cotton ropes carried round a flywheel only represent a main belt that is split up longitudinally into a number of small belts.

Turning first, however, to see what has already been done in the direction of rope gear for electric light work, there may be instanced at once two of the most important installations in London where cotton ropes are used with perfect success; and probably the number of such stations will be increased when the city lighting is an accomplished fact.

The first of the two instances to be noted may fairly take the palm as the largest and most boldly planned electric lighting station in the world; needless to say, then, that it is situated at Deptford. The "baby" engines at this well-known "lightning factory" indicate about 700 H.P. apiece, but this is such a trifle in comparison with the output derivable from the 10,000 H.P. engines which are to be erected, that it is no crime to charge them with infancy. Each flywheel of these 700 I.H.P. horizontal compounds is 25 feet in diameter, weighing some 18 tons, and carefully boarded over—in orthodox fashion—to reduce windage. There are 17 grooves on the flywheel, and 16 ropes are employed to transmit the power, leaving a single empty groove. The ropes are $1\frac{3}{4}$ inches diameter. The dynamo pulley is about 5 feet diameter, so that engine speed is one-fifth that of the armature. This gives a peripheral or rope speed of 3,900 feet per minute.

On the larger set of engines at this station—vertical compounds, indicating 1,250 H.P. each—the flywheels are a trifle smaller, being only 22 feet diameter. The dynamo pulley is given at 8 feet diameter, and the respective speeds of engine and dynamo, 60 revolutions and 170 revolutions approximately. This gives a somewhat higher rope speed than in the previous instance; the average velocity is 4,200 feet per minute. The ropes are 38 in number, and of rather less diameter ($1\frac{3}{8}$ inch) than those used on the smaller engines. There are 40 grooves on each flywheel and dynamo pulley.

The intention as to the 10,000 H.P. engines is of course to drive direct, the dynamo armatures serving practically as the engine flywheels. An output of $7\frac{1}{2}$ million watts would be rather too much to obtain through the intermediary of cotton ropes in reasonable numbers, besides which, the speeds of engine and dynamo approximate so closely that it is not worth while introducing any gear whatever. It should be said that rope gear is used for driving the exciters that provide current for the smallest set of dynamos, two $1\frac{3}{4}$ inch ropes being sufficient for the purpose. A suitable pulley is fixed on each dynamo spindle.

The second electric light station in the Metropolis, where cotton rope gear is employed, is also one that swears by the alternating current, viz., the West Brompton station of the House-to-House Electric Supply Company, Limited.

At the present time there are three large horizontal compound engines installed, each indicating about 200 H.P. The flywheels are 14 feet diameter with grooves for seven 1½ inch ropes; the dynamo pulleys are 40 inches diameter. The respective speeds are as near as possible 1 : 4¼—80 to 85 for the engine and 350 for the dynamo. This gives a peripheral speed of some 3,700 feet per minute. In a similar fashion to that adopted at Deptford, the exciters are also driven by ropes, four of ¾ inch diameter being used for each machine.

Before going into the question, however, of comparing ropes with any other form of gear, something should be said with regard to the use of ropes on quite small engines. Probably it was in this direction that cotton ropes were employed first of all in electric lighting work.

Nearly ten years ago Mr. J. S. Raworth used this method with considerable success in the early days of ship lighting; and it has by no means died out or been supplanted by other systems, even by the same engineer's well-known friction gear.

The reasons which led to the adoption of this gear, even for such small outputs as 20 H.P., will be fairly obvious, but there is no harm in detailing at least some of them. First of all, space on board ship was, and is, so exceedingly precious, that the electrical engineer (he's a more important man, now) had to put up with a pocket edition of an engine and dynamo room, and belt driving for that reason alone became impossible, owing to the short distance available between the spindle centres. Besides that, steamers do not *always* keep an even keel, and in rough weather one may fancy the serpentine undulations of a leather belt over the pulleys and off them. Then, again, a marine engineer is always more at home with ropes; leather belting savours too much of the respectable stay at home workshop. Rope gear, too, as already stated, is almost noiseless; hence its superiority over toothed gear—another form which has been tried more than once for ship work. Direct driving with slower speed machines has, however, obviated the necessity for gear on board ship; and the rope system for small powers is now principally interesting because of its working details, which differ considerably from the usual practice with large outputs.

Thus, instead of employing several ropes each in a distinct groove, the plan adopted by Mr. Raworth was to splice a long rope into one endless length, and then wind it round the pulleys, crossing over from the last groove to the first by means of a special guide or jockey pulley.

To ensure the rope running fairly, of course, the guide pulley and the rope are made to lie in the same plane; a right angled casting with adjustable bolt slots serving to hold the pulley in any desired position. The use of an endless rope in this fashion introduces some rather debatable points as to its relative merit compared with the employment of many distinct ropes, each in its own groove. Probably the working strain on the ropes is more equalised in the former instance, it being very seldom the case that separate ropes are all taking their share of the work. In practice, indeed, it is found that some of them are at times simply running round, or, rather, being dragged round, whilst the others are doing all the work. This makes it difficult to proportion the diameters of ropes in accordance with such possible work as they may have to do; and, at any rate, it necessitates a very large factor of safety or margin between the average working stress and the ultimate breaking strain. At the same time, it is a much less important matter to have one rope broken out of, say, eight, than it is to get a kink or a break in an endless rope wound eight times round the flywheel and pulley. It is quite possible in the first case to go on working with only seven ropes until such time as the engine can be stopped, and a new rope put on; but when an endless rope breaks, the engineer had better advertise for Alexander the Great to come and cut the Gordian knot. If it is *only* the rope that breaks, of course no harm is done beyond a stoppage for putting in a new rope—a stoppage which may or may not be of vital importance, according to the time at which it takes place—but a rope wildly whirling through the air is not the most soothing companion for an engine driver who has to turn off steam in a hurry, nor yet is it the safest thing to get mixed up with pulleys, bearings, or valve gear. It is an axiom, moreover, with rope driving designers to avoid the use of guide pulleys, and hence the Raworth system has never found service on a large scale. The tendency of guide pulleys, even with the exercise of great care, is to wear the ropes faster; and for large installations it is best to recommend the use of several independent ropes, rather than one long multi-coil rope.

In criticising independent rope gearing as a system applicable to electric work, it may be well, however, to take a survey not merely of what has so far been accomplished in the substitution of ropes for belts or gears, but of the various advantages and disadvantages of the system in a mechanical and commercial sense. One fact remains prominent which has a strong bearing on the subject from an electrician's point of view, and that is that rope driving has, as stated, practically carried all before it as a system for cotton mills. This may not at first seem important to anyone unacquainted with the requirements of a cotton spinner. These are in the main—

(1) Steady turning.

(2) Freedom from breakdown.

In order to adequately treat this topic, we cannot do better than trace briefly the history of cotton mill gearing so as to bring out the points to which we think the attention of electricians should be given. Let us go back fifty years and see what was then the system of driving.

In those days of water-twist, when mills were long and narrow structures, an average factory would contain probably 20,000 to 25,000 spindles. For this load a beam engine of a nominal power of 60 horses would be employed using steam at 7 to 10 pounds gauge pressure, and revolving something less than 20 times a minute. The coarser machinery in the "scutching hole," as this department was termed, would often have a separate engine.

The beam engine which would have a 42-inch cylinder would be fitted with a flywheel of about 30 feet diameter of comparatively light rim section, and on the same shaft a large spur wheel of 26 feet diameter with teeth of 8 inches in breadth by 2¾ pitch would drive three separate pinions on second motion shafts.

When the line shafting was light and easily sprung, every stroke of the engine was not merely audible by reason of the constant velocity variation due to flywheel insufficiency, but was actually visible in the appearance of the rapidly revolving spindles.

The change from this system to that of a pair of engines coupled at right angles on the same crank-shaft and driving a spur flywheel was due to Fairbairn, of Manchester, and was an immense improvement; but as steam pressures continued to increase, the impulse of the steam cut-off in the cylinder, at an earlier point, gradually became proportionately greater than the mean turning effort, and the fly spur wheel not increasing in size or weight, became less efficient in maintaining regular speed.

Up to the time of the American Civil War, American cotton of good quality was either used alone or in very large proportions in the mixtures, and the good spinners never dreamed of using anything else. With the stoppage of the American supply, large quantities of very inferior Surats had perforce to be used, and much waste was also worked up, and the poorer quality of the material had undoubtedly its effect in promoting a demand for steady turning. This happened coincidently with a very considerable rise in steam pressures, and a general wakening up of the trade by the co-operative movement, and the building of the first "limited" mills. Compounding, too, was coming to the front; many engines were overloaded, and many others were geared in an inferior manner by ignorant men who had sprung up more quickly than they could learn their business. Breakdowns became frequent, and millowners welcomed the system of belt driving introduced from America. It was soon recognised that belts, to be efficient, must travel at a high speed, and so there grew up a call for the horizontal engine, running much faster than the old beam engines, and with belt flywheels of large diameter. They were found to give excellent results in steadiness of turning, which was wrongly, but very naturally, attributed to the belts *per se*, as though a belt had some special quality in itself which gave it precedence over toothed gearing. It is scarcely necessary to say that the improved turning effort was due solely to increased efficiency of the flywheel, on the one hand, coupled with more frequent reciprocation on the other, which gave less violent impulses at more frequent intervals.

The trouble with belts was their slapping about; they were of large area for their weight, and our experience points to the desirability of limiting the breadth per belt to 30 inches, or 36 inches at most, any larger width being made up of two belts side by side, so as to allow air to escape freely from under them.

Belts also take up considerable space per horse-power, and require wide pulleys to run upon. These, of course, are heavy, and add to the steady turning.

Though it was generally conceded that belt driving involved an expenditure of horse-power about 5 per cent. in excess of that required to transmit an equal duty through toothed gears, this fact would not have prevented the extension of the belt system. To what this five per cent. is due is not very clear: unequal duty at different parts of the belt and friction from crowning when present, air resistance, increased engine resistance, and the friction of heavy flywheel shaft bearings all conduced, no doubt, to the total; but what really stood in the way of belt driving was the difficulty of splitting up the power. After all was done, gearing had to be adopted on second motion shafts.

The idea prevailed that a main driving belt must necessarily be of large width. Now, a double belt of, say, $\frac{3}{8}$th-inch thickness, will transmit about 15 I.H.P. for each inch of breadth. Taking two ropes as a minimum ever seen driving any cotton mill shaft, this is equal to 100 H.P., for which a belt of 7 inches in breadth would suffice. Had belt makers made such narrow belts, and made them good and straight, so as to run evenly on a pulley, there should have been no reason why such belts should not have been run as now are ropes taking power to each line shaft in a factory. With ropes it is not possible to proportion the rope allowance to the work of a shaft driven. Anything over 50 horse-power, or a multiple of that, calls for an additional rope; but with belts, if the shaft is known to require a certain power, it can be exactly fitted with a belt made to the size demanded, no unnecessary material and breadth being sacrificed.

Assuming our figures to be correct, we see that power which calls for a breadth of 7 inches of belt may be transmitted by a couple of ropes occupying not more than $4\frac{1}{2}$ to 5 inches, including the space occupied by the metal rib forming the sides of the grooves. However, in spite of this fact, belts might have held their own had they been properly looked after.

The impossibility of adjusting ropes to their duty nearer than a maximum of 50 horse-power involves, of course, a possible extra ropage of one for each driven pulley, and a total considerably larger than the number indicated by the expression $\frac{\text{I H P}}{50} = \text{N}$. This is so far a disadvantage, but ropes have all the same come out at the top, and there must be a reason, or reasons, and this is not far to seek. The main, or driving pulley, is large and very heavy, and has an immense store of rotative energy. Rope-geared engines may be run at a high speed.

Ropes are elastic, and transmit any possible pulsation in the driving rim very slightly to the driven rims. The final result is extreme regularity of turning effort at the spinning spindles, and this reduces the output of waste, admits of the use of shorter stapled (therefore cheaper) cotton, and generally is an advantage. Further, ropes being of cotton were popular, because they were composed of the production of the factories they drove and so "helped trade." It may be said, how do ropes hold their own in face of the fact that they are generally acknowledged to require some 10 per cent. more engine power for the same duty in number and velocity of spindles turned?

Though they may absorb power, it may be that the type of engine possible with ropes is more than 10 per cent. cheaper in fuel than the geared engine; and after all the final test of power cost is based not on the coal per indicated horse-power, but on coal per pound of yarn produced, and that mill manager who can point to a production of 1 pound of 32s. yarn per 1·9 pounds of coal consumed is in a better position than the man who only turns out a pound of yarn for each 2 pounds of coal, and yet the latter man may burn $1\frac{3}{4}$ pounds of coal per horse-power per hour, and the former may burn 2 pounds per horse-power.

Exactly the same reasons will apply to the use of ropes in electrical work. In this, however, they will usually have the advantage that each engine will have to drive only one or two dynamos, and the number of ropes in excess of nominal requirements will not be more than one or two at the outside. There is no reason why rope-geared engines should not apply as economically to producing electrical energy as to producing yarn. A rope-geared installation requires, however, to be carefully calculated and designed.

The points requiring attention are: Diameters of pulleys, diameters of ropes, and velocity of ropes.

These three items are all more or less dependent one upon another.

Amongst Lancashire engineers, by whom rope driving has been mostly practised, the following items may be said to form the basis of their practice:—

No pulley to have a diameter less than 30 times the diameter of a rope.

The minimum rope diameter is $1\frac{1}{2}$ inches where pulleys can be used of sufficient diameter.

This, of course, implies a minimum pulley of 45 inches. For efficiency of ropes some assume a 2-inch rope at 4,000 feet velocity, equal to transmitting 50 I.H.P.; others that a $1\frac{3}{4}$-inch rope will transmit 10 I.H.P. for each 1,000 feet velocity, or 40 I.H.P. at 4,000 feet per minute velocity. The limit of velocity is taken at 7,000 feet per minute; beyond this there should be a change in design; a speed of 5,000 feet is held as an ordinary maximum velocity, and was the figure selected by the late Mr. W. Inglis, of Bolton, as a proper convenient working velocity.

The stress in a rope is three-fold, and made up as follows:—

(1) The working pull in the rope which is usually figured from the indicated horse-power. This really gives the pull on the assumption that all the power in the cylinder gets past the driving rim—an assumption on the safe side.

(2) Centrifugal stress, the outcome of the speed of rope and its weight per foot of length.

(3) The slack side tension, which may be taken as a tenth of the total rope stress.

The following total stresses represent much of the best practice of the North as deduced from the stresses in ropes of from $1\frac{3}{4}$ inches to 2inches diameter:—

TABLE I.

Diameter of rope.	¾-in.	⅞-in.	1-in.	1¼-in.	1⅜-in.	1½-in.	1⅝-in.	1¾-in.	1⅞-in.	2-in.
Stress per rope in pounds.	110	150	195	246	300	360	430	500	600	675	780
Smallest pulley advisable.	22½″	25½″	30″	34½″	37½″	42″	45″	48″	52½″	57″	60″

If from the total stress we deduct a tenth, we get the allowable working tension which is made up of the transmitted strain and the stress due to velocity of rotation.

This gives us in Table II. the net stress per rope as $\frac{9}{10}$ths that of Table I., or as follows:—

TABLE II.

Diameter of rope.	¾-in.	⅞-in.	1-in.	1¼-in.	1⅜-in.	1½-in.	1⅝-in.	1¾-in.	1⅞-in.	2-in.
Tension..	100	135	175	220	270	324	387	450	540	607	702

These last figures now become reduced by the centrifugal tension. This, of course, depends upon the speed and weight of the ropes, and for the latter the figures of Table III. may be taken as fairly close to the actual weight of ropes per foot:—

TABLE III.

Diameter of rope.	¾-in.	⅞-in.	1-in.	1¼-in.	1⅜-in.	1½-in.	1⅝-in.	1¾-in.	1⅞-in.	2-in.
Weight per foot in pounds.	·18	·25	·33	·40	·50	·60	·72	·84	·98	1·125	1·3

The centrifugal stress due to velocity is found by the formula $c = \frac{w\,v^2}{g}$, where v^2 = velocity per second, and w = weight per foot in pounds; g being gravity, or 32·2. We can readily make a table of centrifugal tensions as Table IV. for speeds of, let us say, from 50 to 120 feet per second, and based upon the foregoing weights per foot :—

TABLE IV.

Speed per sec.	Rope Diameters.										
	¾-in.	⅞-in.	1-in.	1¼-in.	1⅛-in.	1½-in.	1⅝-in.	1¾-in.	1⅞-in.	2-in.
50	14	19	26	32	39	47	57	66	76	89	100
60	20	28	37	45	56	68	82	95	109	128	144
70	28	39	51	62	77	93	111	120	148	175	196
80	30	50	66	80	100	121	145	170	193	228	256
90	38	63	84	102	126	153	184	213	245	290	325
100	48	78	104	127	156	190	227	263	306	357	400
110	57	95	127	152	190	228	275	318	367	432	484
120	68	112	150	181	225	272	327	379	436	500	576

If, now, we subtract the centrifugal tension of a rope at any speed given in Table IV. from the net available strength of Table II., we get a figure which represents the pull available for work.

For example, a 1¾-inch rope has a net strength of 540 lbs. At 50 feet per second its centrifugal stress is 76, leaving a margin for work of 540 − 76 = 464 lbs.

At 100 feet per second its centrifugal stress is 306 lbs., and the working margin is 540 − 306 = 234. But at 100 feet velocity each pound of pull has double the effect in work that it has at only 50 feet velocity.

To institute a comparison, therefore, we must multiply each working remainder by the speed, or for the first case 464 × 50 = 23,200 foot second pounds, and 234 × 100 = 23,400 foot second pounds. Here we are face to face with the fact that it does not pay to speed a rope from 50 to 100 feet velocity with any idea of getting more work out of it when the limit of stress is fixed at 600 lbs. for a 1¾ rope. Given a higher limit of total stress, and it would be an advantage to double the speed of a rope running at 50 feet only.

Let us try an intermediate speed, say, 80 feet per second.

Here the centrifugal tension is 193 and 540 − 193 = 347 lbs. working pull, and 347 × 80 = 27,760 lbs. A speed of 80 is thus better than either 50 or 100.

The same calculation made with speeds of 70 and 90 feet show less results than 80 feet and about 83 feet per second, or 4,980 (say 5,000) feet per minute will be found a maximum efficiency.

It is very clear there is exceedingly little difference between the working power of ropes from 60 to 90 feet per second, and they therefore have a wide range of equal efficiency.

In view, however, of the fact that ropes wear and endure when worn higher stresses than when of full weight—that is, higher working pull stresses—there is always an advantage in keeping to high speeds, for then the effect of speed is more telling.

We have already spoken of the increased friction of ropes as compared with toothed gears.

One cause of this is usually claimed to be in the wedge-shaped grooves in which ropes are run. The wedge groove certainly adds immensely to the grip of a rope, increasing its frictional adhesion, not merely according to the acuteness of the angle of the groove sides, but also by reason of a peculiar longitudinal wedge action, which arises whenever the rope tends or begins to slip round in its groove. Ropes are sometimes made of wire, about ⅝-inch diameter, encircled by leather washers of 1½ inches diameter, closely threaded on. Such ropes are not run in wedge grooves, but the pulleys are turned up with grooves having semicircular bottoms, upon which the ropes run. Every rope thus runs on a pulley of a fixed known diameter.

Where wedge grooves are used, this is not the case. Some ropes are larger, or softer, or harder, than the standard rope, and every difference of size or texture causes a rope to run upon a different diameter. It has a different pitch line in fact. When two ropes thus working on pitch circles differing, say, by only one-eighth of an inch in diameter, drive the same driven pulley, one of them must slip, for the ratio of the driven and driving pitch circles is thereby altered as between two ropes.

It may well be considered whether, in the wedge groove system, the bottom of the wedges need be, as now, continued so far that the rope can never touch it, and whether better results would not be obtained by so forming the grooves, that after a short period of wear, a rope would touch the groove bottom.

Experiments are wanting to show whether or not the adhesion of cotton ropes would be sufficient on round bottomed grooves.

In cotton machinery, as in the mule, the rim bands or ropes of about ¾-inch diameter have always been run upon wedge grooved pulleys, but such rim bands have a far more severe task to perform—one of an alternating stop and start nature—than have main driving ropes continuously and uniformly in motion in one direction. The rim band pulley, however, seems to be the original of the main pulley groove without sufficient enquiry having been made as to its absolute necessity.

In criticising rope driving for dynamos in large installations, we do so with a view to placing the whole subject on a better basis, more solid and enduring than has yet been the case. Driving dynamos is not any way different from driving a cotton mill. Both call for steady and regular turning with no sudden speed variation. This cannot be obtained without considerable stored energy in moving parts, and it is not unlikely that the future electric installation will approximate more and more to the type of the textile factory both in size and stability of engines, and also in the types of boiler employed.

Cotton ropes are by no means essential; they are favourites in the cotton trade, but hemp may be used, wire with leather washers as above described; or ropes of square section made of narrow strips of leather (breaking joint) will work exceedingly well, and have been considerably employed in Yorkshire by woollen manufacturers. They are of course run in square or half square grooves with one diagonal placed vertically. Such ropes are easily spliced without any variation in thickness. We have seen ordinary wire nails used for the purpose.

For cotton ropes at maximum efficiency the horse-power per rope will work out as per Table V.

TABLE V.

Diam.	¾-in.	⅞-in.	1-in.	1¼-in.	1½-in.	1⅝-in.	1¾-in.	1⅞-in.	2-in.	2⅛-in.	2-in.
I.H.P.	9	12	16	20	24	28	34	41	49	54	63

For leather there is usually allowed 13 I.H.P. per inch breadth of ⅜-inch double belting, and a maximum efficiency speed of 90 feet per second, giving a centrifugal stress of 40½ lbs. In a square rope of 1½-inch side and four strips thick this becomes 243 lbs., and with an allowance of 720 lbs. total stress, excluding initial tension, we get 78 I.H.P. for a 1½-inch square leather rope.

This occupies rather over 2 inches of breadth of pulley face, and if our assumptions of strengths, &c., be correct, there is thus obtained from each 2 inches of space occupied by 1½-inch leather ropes 15 I.H.P. more than is given by 2-inch ropes of cotton.

These facts would appear to point to the employment of leather ropes for high-run speeds and space economy, whilst generally it may be observed that the larger the diameter of any rope, the greater will be the power obtained from a unit of width of pulley face.

At the risk of appearing over exact, let us emphasise the desirability of balancing all driven pulleys. This should be done exactly as is done with ordinary leather belt pulleys, upon a pair of bevelled straight edges by the gravity and rolling method. Where high speed rope pulleys are very wide, as for example, those at Deptford, turned for 40 ropes, the balancing should be not merely in the matter of rotation, but should be such as to prevent the formation of a couple when rotating, which can only be done by attaching the balance necessary, in the same plane of rotation as the C.G. of the disturbing element.

As regards proportions of bearings, these should be ample, and never less than four diameters long, for the steady pull of ropes is far more severe upon bearings than the more vibratory pressure caused by toothed gears. In designing engines for rope driving, too, it may be pointed out that the heavy weight of rope driving fly pulleys is much in excess of the older spur geared fly rims, and bearings for crank shafts must be of large area. A good rule is to allow 130 lbs. per square inch of nominal area of neck, such nominal area being the product of neck length by diameter.

With any area the shaft pedestals require to be set parallel with the shaft, and this will always bend slightly, so that the pedestals require a cant inwards to bring the lower brasses parallel with the lower side of the necks.

THE ELECTRIC LIGHTING OF DUBLIN.

IT will interest many to know that the work on the Corporation electric lighting station has been at length commenced, and that the foundations for the main buildings are now being prepared. The excavations have reached the old river bed at a depth of about 12 feet below the present road level. The site, which lies between Parliament Row, commonly known as "the back of the bank," and Anglesea Street, is about 130 feet long by 100 feet at its greatest width, tapering off to 60 feet at the Anglesea Street end. The main building will be erected by Messrs. Beckett and Co., of Ringsend, and the work will be engineered for the Electrical Engineering Company of Ireland, who are the contractors with the Corporation, by Messrs. Hammond and Co., of London.

According to the plans, the main buildings will consist of a handsome three-storey house for offices, test-room, &c., and an engine house, at the rear of the engine house will be the boiler house and coal store, with a chimney shaft standing 120 feet high. On the ground floor the inquiry office and switch room will be placed. Over these rooms will be the general office and test room, and over these again a drawing office and small stores. There will be three main engines specially designed by the engineer of the Electrical Company, each of which will be capable of developing about 300 horse-power. They are being built by Messrs. Coates and Co., of the Lagan Foundry, Belfast, and they will be compound, fitted with Corliss valves on both cylinders. No belts will be used, all the power being transmitted by ropes. Each of the main engines will have as many as 12 of these ropes between its flywheels and the private lighting dynamos which it drives. The latter will be of the Lowrie-Hall type, and have been specially designed for the contractors. The alternators will furnish current at a pressure of 2,000 volts, reduced to 100 volts by means of transformers. This apparatus will be under the control of the Corporation, subscribers only having access to the wires with the 100 volts pressure.

The alternators will stand about 7 feet high, and will weigh about 11 tons. The armature will make 350 revolutions per minute. The exciters are driven from the shaft of the alternators by means of four cotton ropes. The alternators working together will be capable of feeding about 10,000 incandescent lamps, all burning at the same time. This means probably twice as many erected in consumers' houses, for it never happens that all lamps are burning at the same time.

The public lighting plant will consist of three semi high-speed engines, built by the Brush Electrical Engineering Company, of London and Loughborough, each capable of developing 60 horse-power on the flywheel. They are of the vertical open front type, and will run at about 220 revolutions per minute. The power will be transmitted by means of eight cotton ropes to the public lighting dynamos, which are all of the well-known Brush type. Each of these dynamos will be capable of lighting 55 arc lamps, each lamp of 2,000 nominal candle-power, so that the available power of the generating plant for the purposes of public lighting is almost double the present requirements of the Corporation scheme. In the near future we may consequently reckon with confidence on the extension of electric lighting to most of the leading thoroughfares. In the boiler house four large boilers of the Babcock and Wilcox pattern will be erected, each capable of evaporating 8,500 lbs. of water per hour. These will separately have 112 tubes, in which the water will be contained, and around which the fire will play, thus rendering them rapid steam raisers. Facing the furnace doors the coal bunkers will be placed, within easy reach, and on top of these will rest the water tanks, which will have a combined capacity of 21,000 gallons.

The switch room will be an interesting portion of the central station buildings. There all the main cables, public and private, will be arranged before the currents are distributed over the city, and there every circuit will be tested night and day and automatically registered, so that a permanent record of the working of the machines may be kept. In this room all the connections between the various dynamos and mains will be made.

The portions of the city to be first lighted are Sackville Street (Upper and Lower), Westmoreland Street, Grafton Street, College Green, Dame Street, Parliament Street, Capel Street, Mary Street, Henry Street, College Street, and D'Olier Street. This extensive district will be served by underground mains carried in cast iron pipes. There will be three lines of pipes in the streets, each pipe containing at least a couple of cables, the total length of the pipes being about six miles, and of cables at least double this number of miles. A service box will be provided, from which consumers' wires may be taken, opposite the parti-wall of every alternate house along the route of the pipes, and there will be man-holes and boxes through which the cables themselves may be manipulated by the Corporation electrical staff. The Electrical Engineering Company of Ireland have undertaken to maintain the works for twelvemonths after completion, and they have every incentive to work energetically on this great undertaking, as the successful carrying out of their contract will at once satisfy the public and justify the action of the Corporation in entrusting to this young Irish company the important work of the electric lighting of Dublin. So energetically, indeed, will the contract be proceeded with that it is highly probable that the portions of the city mentioned will be illuminated with the electric light early in the coming month of November.

ADDITIONAL FACTS CONCERNING THE TRANSMISSION OF FORCE BY ELECTRICITY: AN ELECTRIC RAILWAY, AS INVENTED BY ALEXANDER BESSOLO.

BY A. M. TANNER.

CERTAIN typographical errors crept into my article on the foregoing subject which appeared in your issue of the 19th inst. The last three lines of the extract from the French patent should read, "communiqueraient leur courant à un moteur electro-magnetique mis en rapport avec la machine *outil* executant le percement et placée dans la galerie même."

In order that the French description concerning the transmission of force by electricity may be more easily understood by the general reader, I will give a free English translation of it, viz. :—

"*Transmission to a distance.*—In the case where there is need of the work of any motor at a certain distance from the point of location of the latter, the force is employed to directly operate a magneto-electric machine, which by means of telegraph wires conveys the current to an electro-magnetic motor. Thus, for example, in tunneling mountains waterfalls and the wind are utilised for setting in motion one or several magneto-electric machines, which communicate their current to an electro-magnetic motor directly connected with the boring machine, and located in the gallery itself."

In connection with the application of electric motors for railway propulsion, an important correction is to be made in the description as given in my article. The Bessolo patent (printed in volume 44, 2nd series of French Patents, page 94) does not state that either the "track rails *or* an

overhead conductor are employed to convey the electric current;" but it distinctly states that "the current is conveyed to the locomotive machine by means of the rails *and* a conductor insulated from the ground and suspended on posts in a manner analogous to telegraph wires. It will be seen that this description clearly indicates that Bessolo had in view the modern electric railway in which an overhead conductor and the track rails constitute part of the electric circuit. The omission of the description of a travelling connection between the overhead conductor and electric motor on the car, does not change the force and bearing of the Bessolo patent when treated from an historical and not a legal point of view. The writer has to state that the original article on the Bessolo patent was written by him so as to set forth the combination of the overhead conductor and rails to form part of the circuit in an electric railway. When his attention, however, was drawn to the article in *La Lumière Electrique*, of December 10th, 1883, he found there a statement that "the rails *or* an overhead conductor served to convey the electric current." Thinking that he had made a mistake in transcribing the French patent description, the article was changed so as to make it appear as if the overhead conductor and the rails were considered as alternative. It now appears that they were intended to be used together, and that the description in *La Lumière Electrique* needs correction.

THE EDISON INCANDESCENT LAMP CASE IN AMERICA.

THE arguments in the suit of the Edison Electric Light Company against the United States Electric Lighting Company were concluded on the 4th inst. Judge the Hon. W. J. Wallace said he would announce his decision as soon as possible, but he intimated that it was doubtful if he gives it before the 1st of July, after which time appeal would go to the New Court of Appeal to be organised by that day.

The action brought in 1885 by the Edison Electric Light Company against the United States Electric Lighting Company, in the United States Circuit Court for the Southern District of New York, came up for final hearing before Hon. W. J. Wallace, Circuit Judge, on May 25th. Eaton and Lewis, solicitors for the complainant company, were represented by Richard N. Dyer, Grosvenor P. Lowrey, Clarence A. Seward and Sherburne Blake Eaton, as counsel. Messrs. Duncan, Curtis and Page, solicitors for the defendant, were represented by Samuel A. Duncan, Edward Wetmore, Leonard E. Curtis, and Frederick H. Betat, as counsel. The preliminaries having been arranged, the hearing was adjourned to May 26th, at 11 o'clock, at which time the opening argument in behalf of the complainant was begun by Richard N. Dyer.

ARGUMENT OF MR. DYER FOR THE EDISON COMPANY.

Mr. DYER said that this was a suit of the Edison Electric Light Company against the United States Electric Lighting Company, upon a patent of Thomas A. Edison for an improvement on electric lamps, granted January 27th, 1880, which patent, the complainant contended, covered the modern incandescent lamp with which we have of late years become familiar as a means of household lighting. Mr. Dyer then handed to the Court a model of the lamp described in the patent, which latter he proceeded to read as follows (the non-essential portion we omit):—

Specification forming part of Letters Patent No. 223,898, *dated January 27th*, 1880. *Application filed November 4th*, 1879.

To all whom it may concern:

Be it known that I, Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, have invented an improvement in electric lamps, and in the method of manufacturing the same (Case No. 186), of which the following is a specification:—

The object of this invention is to produce electric lamps giving light by incandescence, which lamps shall have high resistance, so as to allow of the practical subdivision of the electric light. The invention consists in a light-giving body of carbon wire or sheets coiled or arranged in such a manner as to offer great resistance to the passage of the electric current, and at the same time present but a slight surface from which radiation can take place.

The invention further consists in placing such burner of great resistance in a nearly perfect vacuum, to prevent oxidation and injury to the conductor by the atmosphere. The current is conducted into the vacuum bulb through platina wires sealed into the glass.

The invention further consists in the method of manufacturing carbon conductors of high resistance, so as to be suitable for giving light by incandescence, and in the manner of securing perfect contact between the metallic conductors or leading wires and the carbon conductor.

. . . . . .

When fibrous material is used the plastic lampblack and tar are used to secure it to the platina before carbonising.

By using the carbon wire of such high resistance I am enabled to use fine platinum wires for leading wires, as they will have a small resistance compared to the burner, and hence will not heat and crack the sealed vacuum bulb. Platina can only be used, as its expansion is nearly the same as that of glass.

. . . . . .

I claim as my invention:—

1. An electric lamp for giving light by incandescence, consisting of a filament of carbon of high resistance, made as described, and secured to metallic wires, as set forth.

2. The combination of carbon filaments with a receiver made entirely of glass, and conductors passing through the glass, and from which receiver the air is exhausted, for the purposes set forth.

3. A carbon filament or strip coiled or connected to electric conductors so that only a portion of the surface of such carbon conductors shall be exposed for radiating light, as set forth.

4. The method herein described of securing the platina contact wires to the carbon filament and carbonising of the whole in a close chamber, substantially as set forth.

Mr. DYER, commenting upon the terms employed, defined subdivision to be the production of small lights capable of use in lieu of gas jets, at a cost which brought them within reach of the public. The important features of the Edison burner were its great resistance and its slight surface. The patentee and the complainants believed that former experimenters had worked in the direction of reducing, instead of increasing, the resistance of the carbon rod. The patentee had not only reversed the practice, but he made the important discovery upon which that reversal is based, namely, that carbon in a high vacuum has such stability that even a filament made by heating cotton out of contact with the air—very fragile and very delicate—can be practically maintained in operation.

By using such fine and high resistance carbons it became possible to employ thin platinum wires for leading-in wires, which could be sealed into the glass, and would not heat and crack the bulb, a high-resistance carbon requiring so small a current to raise it to incandescence.

Claims 1 and 2 were stated to be points whereon the plaintiffs based their action for infringement against the defendants.

Mr. DYER then handed to the Court the lamps alleged to be infringements on the Edison patent, one being a Maxim lamp with M-shaped paper carbon, another having a zig-zag carbon, also of paper. The third lamp had a zig-zag burner of Weston tamadine. Mr. Dyer said that to avoid any misconception of the scope of the patent as contended for by the complainants, he would read from the testimony of Prof. Barker, complainants' expert, who was of opinion that each of the three lamps contained all the elements of the first and second claims, combined and operating in the same way and for the same purpose. The differences of the materials of the bridges was merely a matter of detail.

The counsel then proceeded to say that the Edison patent had several times been a matter of judicial interpretation and construction, and gave an epitome of the English cases, which we need not enter into here.

The litigation in Germany dates from 1884, when a suit was brought to annul the Edison patent as invalid in view of the prior state of the art, was decided in favour of the patent March 9th, 1885. In a subsequent suit Naglo Brothers were held as infringers, but on May 5th, 1890, on appeal, the decision was reversed, and the Swan lamp made by Naglo held not to be an infringement. In this German case the question arose entirely on the first claim.

He came next to the case of the Consolidated Electric Light Company against the McKeesport Light Company, decided by Mr. Justice Bradley, October 5th, 1889. The parties there were practically the same, except that the complainant here was the defendant there. Handing to the Court a copy of the Sawyer and Man patent, the subject of that suit, Mr. Dyer said that Judge Bradley decided that what was described in that patent was not new and did not advance the art, but that what was described in the patent here in suit was new, and was the particular invention which established the art of incandescent lighting. After filing the application for the patent in suit November 11th, 1879, Mr. Edison filed another application claiming paper as an incandescent conductor, thus attempting to patent a particular material which fell within the general scope of the first patent. Soon after Sawyer and Man filed an application upon the same thing; an interference resulted which was contested for several years, and finally decided in favour of Sawyer and Man. After this decision the application was expanded by amendments; Edison was no longer using paper but bamboo, so the application of Sawyer and Man was enlarged to cover fibrous materials generally, and upon that patent suit was brought. It was set up in behalf of Edison, not only that the use of paper was not new, but that Sawyer and Man were proceeding upon principles of construction proved over and over again to be impracticable, whereas that which was practicable, and which established the art of incandescent lighting, was Edison's invention of *the filamental carbon in a high vacuum in an all-glass sealed vacuum chamber*. So that when in this case Justice Bradley passed upon the question as to what the real invention was, all the testimony and all the state of the art was before him. Justice Bradley said that "the great discovery in the art was that of adopting high resistance in the conductor with a small illuminating surface, and a corresponding diminution in the strength of the current. This was accomplished by Edison in his filamental thread-like conductors, rendered practical by the perfection of the vacuum within the globe of the lamp." Again Justice Bradley said: "We think we are not mistaken in saying that but for this discovery electric lighting would never have become

a fact. We have supposed it to be the discovery of Edison because he has a patent for it. This may not be the case; it may be the discovery of some other person, but whoever discovered it, it is undoubtedly the great discovery in the art of practical lighting by electricity."

Having placed before his Honour the patent in suit and having referred to the decisions affecting it, Mr. Dyer said that before entering upon Edison's work he would proceed to explain some of the electric principles underlying the art. He then explained, and illustrated by means of diagrams, the distinguishing characteristics of the arc and incandescent lamps; the meaning of the terms electromotive force, resistance and current, and the units of measurement which have been adopted, the whole being admirably illustrated by models showing sections of actual wires and rods of different metals and of different cross-sections. He also explained the difference between the *specific* resistance of a conductor, which depended upon its molecular structure, and its *absolute* resistance, which was determined by its form and size as well as by its material. The enormous difference in the resistance of a metallic and a carbon rod of equal dimensions was well illustrated in one of the models.

The patent spoke of a filament of high resistance and small radiating surface. The radiating surface was quite as important as the resistance. It was important to remember that radiating surface might be varied independent of resistance. So far as resistance was concerned it was immaterial what the shape of the cross-section might be, but every change in the shape of the cross-section changed the extent of the radiating surface. This was illustrated by a model. The next important fact was that the quantity of heat developed in a conductor by the flow of the current was independent of surface, but the temperature was directly dependent upon the surface. He desired his Honour to understand that since the patent called attention to the fact that high resistance and small radiating surface were the objects of construction, the foregoing explanations had a direct bearing on the patent. A high temperature was absolutely necessary to produce light economically, and one way of securing a high temperature was by making use of a small radiating surface. It is a well known fact that at the same temperature bodies will radiate heat more or less according to the extent of the surface. The body of larger surface will radiate more heat than the body of smaller surface. It is also well understood that a body at higher temperature will radiate heat faster than a body at lower temperature.

What, then, is the effect of generating the same amount of heat in two bodies of different surface? In each body the heat will accumulate as it is generated until the temperature of that body is raised to that point where the radiation and generation of heat will be balanced. Then there will be no further rise in temperature.

Now, in a body of larger surface that point of temperature will be reached at a lower temperature than that required in a body of smaller surface. Hence if the body of larger surface has twice the area of surface of the smaller body, it will also have only half the temperature, although the same energy is developed in it.

This is very largely an economical question. It has always been possible to make electric light, but not until Edison's invention was it possible to do so practically and economically.

Now since it appears that the temperature or degree of heat which a body will attain is inversely proportional to the extent of its surface, let us see what effect that temperature has upon the light which the body will emit. We have in the case the statement made by Mr. Preece, a noted English electrician, who gives us the following data upon this subject: "Heat and light are identical in character, though different in degree, and whenever solid matter is raised to a very high temperature, it becomes luminous. The amount of light is dependent upon the height of this temperature, and it is a very remarkable fact that all solid bodies become self-luminous at the same temperature. This was determined by Daniell to be 980°, by Wedgewood 947°, and by Draper 977°; so that we may approximately assume the temperature at which bodies begin to show a dull light to be 1,000°. The intensity of light, however, increases in a greater ratio than the temperature. For instance, platinum at 2,600° emits forty times more light than at 1,900°. Bodies, when raised to incandescence, pass through all stages of the spectrum; as the temperature increases, so does the refrangibility of the rays of light. Thus, when a body is at a temperature of

250°,	it may be called	warm.
500°	"	hot.
1,000°	we have the	red rays.
1,200°	"	orange rays.
1,300°	"	yellow "
1,500°	"	blue "
1,700°	"	indigo "
2,000°	"	violet "

"So that any body raised to a temperature above 2,000° will give us all the rays of the sun."

The particular fact to which I desire to call your Honour's attention is the illustration that a platinum wire at 2,600° emits forty times more light than at 1,900°. A high temperature is necessary to produce light economically; and one way of securing a high temperature is by producing a small radiating surface, so that the energy which is put into the burner may raise that surface to a high and economical temperature.

A high resistance and small radiating surface make possible the use of a small electric current. That is the fact referred to by Justice Bradley in his decision, in which he says that, "The great discovery in the art was that of adopting high resistance in the conductor with a small illuminating surface, and a corresponding diminution in the strength of the current."

Aside from the effect upon the light produced already explained, the quantity of the current controls the size of the conductor required to deliver the current to the lamp. That is to say, the larger the current the larger must be the conductor which is employed to carry the current to that lamp, and conversely, the smaller the current the smaller may be the conductor which can be practically used to carry the current to the lamp.

A conception of the two-fold character of electric energy is necessary to appreciate this. The energy which an electric current develops is expressed by the product of its pressure by its quantity, from which it follows that a small current flowing under a high pressure may be made to develop the same energy as a large current flowing under a low pressure. This will be the case whenever the product of the pressure and quantity is the same in both cases. It will also be at once perceived that if, in any case, both the pressure and quantity are doubled, four times the effect will be produced.

There is a unit which expresses the combined effect of the pressure and quantity of the electric current, and it is called the "watt," after the inventor of the steam engine.

The flow of water in pipes may be referred to for illustration in this connection, as showing with sufficient accuracy the reciprocal relations of the pressure and quantity of electricity and the relation which the product of these quantities bears to the energy developed or the work done.

To develop a certain power in a water wheel, with a pressure due to a head of one foot, we require a certain large volume of water, the energy developed by which is dependent both upon the head or pressure and upon the volume or quantity flowing—therefore upon the product of the pressure and quantity. The wheel which has to be operated by the flow of a large quantity of water under low pressure must be sufficiently large to accommodate it, and will have a comparatively slow speed; while the wheel that may be operated by a small quantity of water under high pressure may be smaller and will have a higher rate of speed.

We have in this diagram two instances of water wheels; in one case that of a lower pressure, the head of water being 10 feet, and in the other case the head of water being 50 feet.

If the fall in one case is five times what it is in the other, we may get the same result in work accomplished by permitting one-fifth the quantity of water to flow over the wheel at five times the pressure.

That is also true in electricity. We can produce the same result with one volt of pressure and 100 ampères of current that we can produce with 100 volts of pressure and one ampère of current. One difference is the size of the pipe which is required to carry the current in either case. The size of the pipe must be directly proportional to the volume which it has to carry.

Pressure itself requires no space in which to act. It is only when that pressure is used to move a mass that space is required in which the mass must move.

The hydraulic press is an illustration of that, and also ordinary stand pipes for water works, where your pressure is just as great whether the stand pipe is 5 feet in diameter or 50 feet in diameter. The larger stand pipe will supply a larger volume of water. If you want quantity of water you must have a reservoir. You may get the pressure by a standpipe.

It is a very old experiment to break a cask by a very small column of water, by running a pipe from a cask at a sufficient height, filling the whole system with water, and then pouring by the dipperful a few more dippers of water into the upper end of the pipe. The result is that the cask is burst asunder. That is the direct effect of the pressure produced by the height of the water. The energy there is all stored in pressure, and not in quantity at all.

In incandescent lighting the size of the pipe is a matter of importance. In an incandescent electric lamp the same amount of energy or number of watts is developed, as I stated before, whether one ampère is used or 100 ampères. In one case the pressure must be 100 volts, and in the other case one volt. So long as the product of the two is the same, we have the same energy. But the size of the copper conductors necessary to carry the current to the lamps requiring 100 ampères will be many times that necessary to carry the current to the lamps with one ampère. I am told, your Honour, that the difference between the size of the conductors required to carry 100 ampères of current under one-volt pressure and one ampère of current under 100 volts of pressure is ten thousand times. The conductor, in one case, must be ten thousand times the area of the conductor in the other case. That I state only on information. I confess my inability to go to the extent of ten thousandthsin my mathematics.

This reciprocal relation between the pressure and the quantity of the electric current will be better understood in connection with an explanation of what are known in this case as "series" and "multiple arc" arrangements. Your Honour will recollect that the patent in suit says that "one of the disadvantages of following this practice is that a lamp having but one to four ohms resistance, cannot be worked in great numbers in multiple arc, without the employment of main conductors of enormous dimensions," and in order to understand that statement of the patent, contained on the first page near the bottom of the first column, an explanation of what is meant by a "multiple arc," and what is meant by "series," which is the system with which multiple arc is contrasted, is necessary for an understanding of the patent.

"Series" and "multiple arc" are expressions indicating the electrical arrangement or order of the lamps in circuit, the order in which they are connected together, and with the source of electricity. That arrangement is an electrical arrangement, and not a mechanical one, since the wires may be turned in any direction, and, physically, the lamps may be located anywhere with relation to each other.

The invention of Mr. Edison, consisting in making the burner of his lamp of high resistance and small radiating surface, enables him to utilise a small amount of current under the higher pressure; that is, the high resistance of the burner requires a certain high pressure to force the quantity of current through; and having that high resistance, a small current is all that is required to produce the light; that

is, having that high resistance and that small surface (which must always be borne in mind), a small quantity of current is necessary. So it is by his invention, the invention described in this patent, an electric lamp has been produced which is capable of receiving energy and utilising energy in the form of high pressure and small quantity, corresponding to the smaller water wheels; so that with that lamp small conductors may be used and the high pressure will supply the current to the lamps themselves. We see at once, then, the additional thing that is accomplished by high resistance and small radiating surface. Aside from the capacity to give light economically, which is a question affecting the lamp itself, there is the capacity to give light with a small current under a high pressure. That capacity controls the size of the conductors; and the size of the conductor must be small for each lamp in order to enable a large number of lamps to be placed in multiple arc, in which arrangement they can be turned off and on, the same as a gas jet.

The function of the high vacuum and of the entire glass construction of electric lamp chimneys, as well as a due appreciation of what was actually accomplished by this invention, can only be seen after an investigation of the prior state of the art as it existed in the fall of 1878, when Mr. Edison commenced his series of experiments, resulting in October, 1879, in the lamp under dispute.

There are two landmarks in the topography of the prior art. One is the patent of King in 1845; the next is the resuscitation of the art by Lodyguine, a Russian, in 1873. Before the patent of King there had been experiments in incandescent lighting, and the arc lamp had reached a certain stage of development, and had been used. The principle of continuous conductors producing electric light when heated was known, but King's lamp was the first definite form that was published. The King patent described two lamps—the one had a platinum burner not in a vacuum, the other was a lamp having a conductor of carbon. We have produced for the purposes of the case a dummy model of the carbon lamp of King, so as to illustrate the character of the construction. We have a bulb, in which the carbon parts are placed, with a platinum wire sealed in at the top.

Then we have a long tube, which is necessary for forming a Torricellian vacuum. To exhaust this lamp, it is inverted and the mercury poured into the tube and bulb until full. It is then inverted in a cup of mercury, and the mercury will flow out of the bulb into the cup below, thus forming a vacuum in the bulb, known as the Torricellian vacuum. Through the column of mercury runs a copper wire, terminating in the cup of mercury, which is one terminal of the lamp. The current passes up the wire through the column of mercury to the carbon, and out by the platinum wire sealed into the bulb.

The first criticism of the King lamp is that all experts agree that it is not possible to make the carbon bridge in the way described in the patent.

The second—that King's lamp, whether the platinum or the carbon lamp, is a low resistance lamp, having all the disadvantages pointed out in the patent in suit. Having a resistance of only, perhaps, 1 to 4 ohms, the King lamp had to be used in series; the evil effect of this was to prevent each lamp being turned off singly, like gas jets.

Mr. Dyer then proceeded to point out the inconsistency of the testimony of the defendants' experts, Profs. Morton and Cross. Dr. Morton, in an article in *Scribner's Magazine*, referring to the lamps of King and others, had said that the problem of commercial electric lighting by incandescent conductors, notwithstanding the inventions, still remained without a solution. Similar statements had been made by Prof. Cross, while Prof. Barrett, for the complainants, said the method employed for obtaining vacuum must have been very uncertain; not a practical one in a commercial sense.

We find that the King patent was fully considered in an English Court, which expressed its opinion as follows: "Now, comparing this apparatus with the second claim of Mr. Edison, we find a carbon conductor and a vacuum; but we find that the carbon was not required to be a filament; we find that it was placed in a receiver made not entirely of glass, but partly of glass and partly of the top of the mercury column, consequently that the leading wires were to pass, one through the mercury and one through the glass."

Between King in 1845, and Lodyguine in 1873, the record shows only one suggestion of an incandescent lamp having a carbon burner, and that is Roberts's patent granted in 1852. The lamp was a glass chamber or globe closed at the lower end by a metallic cap, through which the leading wires pass, and cemented to the globe. The burner was a thin piece of graphite, or other infusible body, enclosed in a vacuum or space not occupied by any oxygen or other gas that is destructive to the carbon when the latter is in an incandescent state.

Our criticism of this patent is, as compared with the Edison patent, that it describes a low resistance lamp, and one made by reducing the carbon after the carbon itself is formed, that it is impossible to maintain a vacuum in the chamber, and that it is not an advance on King's make of lamp with the exception that the long tube of mercury is dispensed with, and a metal cap substituted which is cemented to the globe. The vacuum would be inferior to King's, while in neither lamp could the vacuum be maintained as well as in a lamp completely sealed within a glass vacuous globe.

The radiating surface and the resistance of the burner play no part in either King's or Roberts's lamp, as far as can be judged by the patents; it was simply a question of producing light. Edison took up the art where electric light had been produced. The effort that he made was to produce electric light practically, to make an electric light that was durable in the first place; and in the second place to make a lamp that could be used by the public, without enormous expense in the cost of conductors, and that would be a simple piece of apparatus that could be handled by the public.

Mr. Dyer next alluded to the abortive attempts of experimenters to produce a subdivided light by Geissler tubes, and then took up the consideration of Crookes's radiometer, in which an electric current was passed through a platinum wire enclosed in a sealed and exhausted glass globe, in order to produce a source of radiation within the chamber to act upon revolving vanes. Of course there was no idea of making an electric lamp, no idea of resistances or radiating surface, or anything of the kind. All Crookes wished to examine was whether the radiation from an inside source of light would be equally effective as the light coming from the outside of the exhausted globes.

The period during which Konn's, Lodyguine's, and Fontaine's lamps were produced was one of active experimentation, having its centre in Paris. The Jablochkoff candle was being used to light the streets of that capital, and everything seemed ripe for the introduction of a divided electric light for interior illumination, provided a suitable lamp could be found. To determine the value of known systems, Fontaine experimented with several Konn lamps, and he published his results in a book in 1877. He says the vacuum was never very perfect at first in the receivers, and that the first carbon was in greater part consumed, and that a kind of evaporation slowly destroyed the rods; this was evidenced by the deposit on the glass receivers. Here was a vital defect. Carbons in an atmosphere not containing oxygen were destroyed.

Quoting Fontaine's statement, Swan said: "If this idea of the carbons volatilising were founded in fact, any further attempt to render incandescent lamps durable by means of a vacuum would be mere waste of time, and durable they must be to be of any practical value." These views were repeated by Schwendler in 1879. Such was the impression left by Fontaine, and hence it was of great importance to understand that the art, as it stood when Edison took up the matter, absolutely excluded the idea of obtaining success by the use of carbon.

Mr. Dyer read extracts from an article by Dr. Morton in the *Gas Light Journal* of October 17th, 1878; his report to the Lighthouse Board in November, 1879, and the work of Bernstein on electric lighting. These extracts supported his contention.

The concrete problem was the subdivision of the electric light. The arc light was the only embodiment commercially of the electric light; the great problem awaiting solution was the subdivision that would furnish lights comparable with gas jets, and which could be turned off and on at the will of the user.

In Fontaine's book there was a celebrated experiment in which he believed he had proved that the electric light could not be subdivided, because a battery sufficient to burn one lamp brilliantly was insufficient to run five lamps. The fallacy underlying this experiment was the assumption that the smaller lights should be produced by passing a smaller current through the same lamp; for in that case the temperature of the carbon was much lower and the light diminished in greater ratio than the temperature. Had Fontaine known how to construct lamps of high resistance and see all radiating surface he would have come to a different conclusion as to the subdivision of the electric light.

Mr. Dyer illustrated this point by showing five lamps of high resistance and small radiating surface, showing that under these circumstances each lamp gave its full light, and that each lamp could be turned off without much variation of light.

"This, your Honour," exclaimed the counsel, "is success; the other may be called failure."

At this point the Court adjourned for the day.

LONDON COUNTY COUNCIL.

THE following report of the Highways Committee was submitted at the last meeting:—

NOTICES UNDER ELECTRIC LIGHTING ORDERS AND ACTS.

We have considered a notice dated June 8th, 1891, from the St. James and Pall Mall Electric Light Company, of intention to lay mains in Carnaby Street, Beak Street, Vigo Street, Sackville Street, Old and New Burlington Streets, Savile Row, Cork Street, Air Street, Piccadilly, and Burlington Gardens (1 map, No. 31, and 2 drawings, Nos. 103 and 104). The company proposes to lay a new feeder from Carnaby Street to Sackville Street, and for this purpose to use armoured Siemens cable, while the mains in the other thoroughfares referred to in the notice will be laid in the iron culvert ordinarily used by the company. There seems to be no objection to what is proposed; but we are of opinion that, in order to avoid prolonged interference with the traffic in Regent Street, the Council should require that the works there should be carried out in the shortest time possible. We accordingly recommend that the sanction of the Council be given to the works referred to in the notice (Registered No. 210), dated June 8th, 1891, of the St. James and Pall Mall Electric Light Company, on condition that the company do give two days' notice to the Council's chief engineer before commencing the works in any of the thoroughfares specified in the notice, and that the works in Regent Street, when commenced, be carried on without intermission by day and by night until completed.

Two notices have been given by the Westminster Electric Supply Corporation, the one dated June 8th, 1891, of intention to lay mains in Allington Street, and the other dated June 9th, 1891, of intention to lay mains in Tothill Street. The proposed works are of the same character as those of this company which have been approved by the Council; and we recommend that the sanction of the Council be given to the works referred to in the two notices, dated June 8th and 9th, 1891, respectively, of the Westminster Electric Supply Corporation, upon condition that the company do give two days' notice to the Council's chief engineer before commencing the work; that the mains

be laid under the footways wherever it is found practicable to do so; and that the covers of the street boxes to be used shall consist of iron frames filled in with material to suit the paving.

The Notting Hill Electric Lighting Company has given a notice dated June 11th, 1891, of intention to lay mains in Addison Road, Holland Road, Napier Road, Melbury Road, Holland Villas Road, and Holland Park Road. There seems to be no objection to the proposed works; and we recommend that the sanction of the council be given to the works referred to in the notice dated June 11th, 1891, of the Notting Hill Electric Lighting Company, upon condition that the company do give two days' notice to the council's chief engineer before commencing the work; that the cover-stones of the culverts under 20 inches wide shall be not less than two inches thick, and of the wider culverts not less than 2½ inches; and that, where the culvert crosses the carriageway there shall be at least nine inches' thickness of Portland cement concrete above the coverstones of the culvert, in addition to the road material.

We have also considered a notice dated June 11th, 1891, from the Kensington and Knightsbridge Electric Lighting Company, of a proposed extension of mains in Queen's Gate. The proposed works are unobjectionable; and we recommend that the sanction of the Council be given to the works referred to in the notice, dated June 11th, 1891, of the Kensington and Knightsbridge Electric Lighting Company.

We have to report the receipt of the following notices given in accordance with the decision of the Council to accept four days' (instead of one month's) notice, in respect of the laying of service lines already laid—10th June, 1891, from the Electricity Supply Corporation—to 50, Strand; and to the Camera Club and Messrs. Kegan Paul & Co.'s premises, Charing Cross Road. 12th June, 1891, from the London Electric Supply Corporation—to the Prince of Wales Theatre, Coventry Street; to the Lyric Club, Whitcomb Street; and to 13 and 96, High Street, Deptford. 18th June, 1891, from the same company—to 144, Regent Street, and 50, Parliament Street.

ELECTRICITY IN THE PRODUCTION OF ALUMINIUM.

By Prof. M. G. FARMER, in discussion of a paper read before the American Institute of Electrical Engineers, by Alex. S. Brown, New York, April 21st, 1891.

DURING the year 1859, while I was experimenting upon wires of different materials for the purpose of producing an electric light, I chanced to try a wire of aluminium. When the wire was well heated by the electric current, I noticed that the light given out by it approached quite closely in brilliancy to that given out by incandescent platinum. When I approached a steel darning needle to the wire loop, I saw that the wire was deflected, as any wire should be which carried an electric current in a magnetic field. Its behaviour was different in this respect: A wire of platinum would retain much of its elasticity even when heated to a high temperature; not so with the wire of aluminium, it seemed to wholly lose its elasticity, and was as mobile or flexible as a string or thread. I do not know what, but something prompted me to puncture the heated aluminium wire, and when I withdrew the darning needle there followed it a stream of melted aluminium to a distance as great as one-quarter of an inch or more. I swung the loop, but the wire did not fall apart, although is was fluid internally, but exteriorly it seemed coated with an oxide which retained its cohesion and supported the wire against gravity. I noticed that the wire after it had been heated and cooled once or twice, was shrivelled and appeared shrunken, like to a shed snake-skin.

My next experiment of promise was in 1856, when I deposited electrolytically some aluminium upon a copper wire. I also coated a German silver spoon with it and the plating was well done, and it wore well. This experiment led me to predict at that time that at some future date aluminium would be produced and sold profitably at 65 cents per pound. I was not so far out, for at this date, 1891, the Pittsburgh Reduction Company offers it for sale at $1.50 per pound, and an inferior quality at 90 cents per pound, although in 1856 I was obliged to pay $2.50 per ounce avoirdupois for the metal which I was using in my experiments. From the counter electromotive force apparent in the circuit, I was led to think that several crucibles or tanks arranged in series would be worked more cheaply than a single crucible or tank. My reasonings on this point led me, in 1885, to apply for a patent, and on April 7th of that year patent No. 315,266 was granted to me, which shows crucibles arranged in series in the circuit. About the year 1863, I commenced making experiments on alloys of aluminium with various other metals, such as copper, silver, zinc, tin nickel, cadmium, iron, &c. I patented two of these alloys, one of which, No. 38,301, covered the composition of an alloy which so closely resembled 18-carat gold as to deceive the most experienced dealers in that metal when judging merely by its looks. I made of this alloy watch cases, chains, thimbles, knives, forks, spoons, and some of these are now in good condition.

The second patent, No. 44,086, was for an alloy which should be adapted for sheathing metal for ship's bottoms, but the then price of aluminium was prohibitory. I made of this alloy keys, ship's nails, balls for grinding gunpowder without striking fire, and many other useful things. I had a blacksmith draw out one of these nails to double its original length without cracking it in the least, and although it was stretched from 2½ to 4½ inches in length, yet it showed no flaw. I drove a nail which was 1¼ inches in length, into a block of lead its whole length without seriously bending or crippling it. I presume that at that date I compounded more than one hundred of these different alloys. I look upon the alloys of alluminium with other metals as a most promising field of investigation. I tested wires made from some of these alloys which did not break short of 130,000 pounds per square inch. The shrinkage of these alloys when cast is remarkable, and needs to be provided against. Among the many of these alloys which I compounded was one which had a peculiar "cry" when passing through the rolls, resembling block tin when it is bent, only that it was much louder, and it lasted as long as ten minutes, perhaps, and it could be heard at the distance of 75 to 100 feet.

I come next to the very interesting paper of Mr. Brown. He says in effect that there is at Boonton a dynamo weighing over 19 tons, which will, at an armature velocity of 220 revolutions per minute, maintain a current of 3,500 ampères under a pressure of 35 volts; of course, the total resistance of the circuit must not exceed ·01 ohm in order for this current to be possible. This resistance must include the resistance of the crucible, plus that of the dynamo, plus that of the leading wires or conductors which complete the circuit. The distance of the dynamo from the crucible is stated to be about 14 feet, and the cross-section of these conductors is given as about 4 square inches; hence this leading wire resistance may be about ·0008 ohm. He does not give us the resistance of the crucible nor its complete dimensions nor the specific resistance of the contents of the crucibles; all we can infer is that the total resistance of the circuit cannot exceed ·01 ohm. Now, a current of 1 ampère can liberate ·00114 lb. of aluminium per hour, hence a current of 3,500 ampères can liberate not more than 3·99 lbs. of aluminium per hour, or 95·76 lbs. in a day of 24 hours, and it would require at least 164·1 horse-power to turn the dynamo while doing it, were the efficiency of the system unity; but as its efficiency probably does not exceed 90 per cent. it would require 183·75 horse-power for the liberation of the 3·99 lbs. in one hour, or at the rate of 46 horse-power for the liberation of 1 lb. of aluminium.

In a recent lecture delivered in Boston by Mr. Alfred E. Hunt, president of the Pittsburgh Reduction Company, he states that it requires about 22 horse-power to liberate 1 lb. of aluminium per hour at their works, and he gives the production as not far from 500 lbs. daily. Possibly even this is not the best attainable result. Suppose that we should employ four crucibles in series in the circuit, as illustrated in my patent, No. 315,266, issued April 7th, 1885, each crucible having an internal resistance of ·005 ohm. Suppose, further, that the dynamo and its leading wires should offer a resistance of ·002 ohm, then the total resistance would amount to ·022 ohm. Now, instead of employing a current of 3,500 ampères, suppose that the current should be reduced to 1,000 ampères, then our hourly production of aluminium from the four crucibles would amount to 4·56 lbs., or 109·4 lbs. in a day of 24 hours. In order to maintain a current of 1,000 ampères in this circuit of ·022 ohm resistance against a counter electromotive force of 14·28 volts, it would be needful that the dynamo should be able to produce a pressure of 33·28 volts.

Next, suppose that we put ten crucibles instead of four into the circuit, with a dynamo that has an internal resistance of ·001 ohm, this includes the resistance of the conductors which lead from the dynamo to the crucibles: suppose, further, that each crucible with its leading wires should offer a resistance of ·001 ohm, then our total resistance in circuit will be ·011 ohm; suppose, also, that our current remains as before, 1,000 ampères, then our hourly production from the ten crucibles will amount to 11·4 pounds, or to 273·6 pounds in a day of 24 hours. To maintain this current of 1,000 ampères in this circuit of ·011 ohm will require that the dynamo shall maintain a pressure of 39·2 volts, and the power required to turn the machine will be 58·8 horse-power, and the hourly production of one pound will require the exertion of only 5·15 horse-power, instead of 46, as in Mr. Brown's case, or 22 in Mr. Hunt's case. Even this economy can be surpassed if we attentively study the following equation: Let p = ·0015 be the horse-power corresponding to one volt-ampère, allowing for an efficiency of 90 per cent. in the dynamo; let q = ·00114 be the quantity of aluminium liberated in a crucible in one hour by a current of one ampère; let N denote the number of crucibles arranged in series in the circuit; let C denote the strength of the current in ampères; let V denote the pressure in volts exerted by the dynamo; let e denote the counter electromotive force encountered in each crucible—I compute its value to be e = 2·82, with a possibility that it may be less at the actual temperature of reduction. Let T denote the time that the current is active in the production of W pounds of aluminium. Then $W = q\,N\,C\,T$, also the power, P, exerted by the engine, will be denoted thus:—$P = p\,V\,C$ and the latter divided by the former will be thus expressed: $P \div W = p\,V\,C \div q\,N\,C\,T$; now, cancelling C from both numerator and denominator, we get $P \div W = p\,V \div q\,N\,T$, and if T be unity, and if for $p \div q$ we substitute their value ·0015 ÷ ·00114 = 1·315 we get $P \div W = 1{\cdot}315 \times V \div N$. Now, substitute for V its value in terms of $C\,B\,R\,N$ and e and we get $P \div W = 1{\cdot}315 \times (C\,B + C\,N\,R + N\,e) = 1{\cdot}315 \times (C\,B \div N + C\,R + e)$, which shows that the power per pound required diminishes as C, B, R diminish, and as N increases, e remaining constant all the while, being fixed by the laws of chemical action.

If we allow $\frac{\$0{\cdot}05}{22}$ as the cost of 1 horse-power, according to Mr. Hunt's estimate, given at Boston, and if we allow $0·06 to be the cost of the ore required to produce 1 lb. of aluminium, allow also $0·01 for the cost of the chemicals used in purifying it and preparing it for the crucibles; allow $0·02 for the cost of carbon anodes consumed per lb. of aluminium produced; allow, also, $0·06 for labour, superintendence, depreciation, interest, &c., substituting our estimate of possibly 5 horse-power per lb. of aluminium per hour, we get its total possible future cost per lb. down to less than $0·17 per lb., or to less than $340 per ton, and if it be sold at $0·25 per lb., or $500 per ton, an establish-

ment which could turn out only 10 tons daily would be in the receipt of a daily profit of $1,600, or a yearly income exceeding $480,000, which would surely pay good interest on quite a large capital; what, then, would be its profits were it to charge $1·50 per lb., as the Pittsburgh Reduction Company charges at the present date of writing? But I must leave this interesting discussion for abler hands than mine.

LEGAL.

Action for the Cost of an Electric Lighting Installation.—In the Court of Session, Edinburgh, on Saturday, Lord Low had before him an action by J. and J. Blair, manufacturing chemists and electrical and mechanical engineers, Irvinebank, Kilmarnock, against J. and R. Howie, Hurlford Fire-Clay Works, near Kilmarnock, and Plann Colliery, Crosshouse, near Kilmarnock, for payment of £88 2s. 7d. The pursuers state that in October, 1890, they, on the employment of the defenders, fitted up at their brick-works at Plann, near Kilmarnock, an electric lighting installation, and the pursuers' account amounted to £88 2s. 7d., which the defenders refused to pay. In reply, the defenders say that by letter dated August 6th, 1890, the pursuers offered to fit up and complete at the Plann Works, for the net sum of £65, an electric light installation consisting of one 30-light Campbell dynamo, 25 16-C.P. incandescent lamps, and 25 lamp-holders and flexible pendants, with all necessary fittings. The letter stated: "All the above to be of the best quality of material, first-class workmanship, and fitted up to your satisfaction." By letter dated August 7th, 1890, the pursuers altered the before-mentioned offer, and offered to supply and fit up in the defenders' works an installation consisting of one Campbell dynamo, 30-light; 14 incandescent lamps, fixed; 10 incandescent lamps, portable; each 16 candle-power, with all necessary fittings, for the sum of £62 10s. After some correspondence and meetings with the defenders, the pursuers on August 27th, 1890, wrote the defenders, offering to fit up the installation for £60. By letter to the pursuers, dated September 2nd, 1890, the defenders accepted the latter offer, and requested the pursuers to proceed with the installation in terms thereof. On September 3rd, 1890, the pursuers wrote the defenders that they took the defenders letter to be an acceptance of their offer of August 7th, 1890, modified in price to £60. To prevent misunderstanding, the pursuers pointed out certain things, including a seat for the dynamo, which were excluded from their offer, and concluded their letter as follows:—"We shall, of course, give you a good and efficient job, and shall do our best to have it ready by the date you name, 22nd inst." By letter of September 4th, 1890, the defenders agreed to the pursuers' conditions, and thereafter the work was proceeded with, and was completed in the beginning of October, 1890. Before the last-mentioned date the pursuers contracted to supply the engine mentioned in the account produced for the purpose of driving the dynamo. On trying the installation the defenders found the light imperfect and insufficient, and utterly useless for their purpose. The light was weak and irregular from the beginning, and the installation frequently failed to act. After repeated attempts on the part of the pursuers to set it right, the installation finally ceased acting, and its use had to be abandoned by the defenders. Further, the engine supplied by the pursuers was quite unfit for its duty. The whole installation has been fitted up by the pursuers in a rough and imperfect manner. The dynamo, in particular, is of an extremely faulty design and inferior workmanship, and runs at an excessive rate of speed for a machine so constructed. When it is running the armature vibrates at such a rate that it is impossible for the brushes to keep in their places, and a lengthened run causes the screws in the machine to fall loose, the adjusting of which necessitates the stopping of the engine. The dynamo is not balanced with sufficient accuracy looking to the rate of speed at which it must run. The pursuers have thus failed to implement their contract, and the defenders have suffered serious loss and damage, for which they reserve their right of action against the pursuers. In respect to the defenders' answer, the pursuers say that the offer of August 6th, 1890, was not accepted by the defenders, and formed no part of the contract between the parties. The pursuers, after an interview with the defenders, and going over their premises and having their requirements explained, made a new offer by letter of August 7th to perform the work therein stated on behalf of the defenders at the price and upon the conditions therein stated. The pursuers explain that this offer did not include the performance of any work connected with the seat of the dynamo machine, nor any ironwork, joiner-work, brick or mason work. They admit also that by their letter of August 27th the pursuers reduced their price to £60 in consequence of the representations of the defenders that they were desirous of having the work performed at the lowest possible price, and their requests to the pursuers to reduce the contract price. The pursuers' offer was accepted by the defenders by letter of 2nd September, but as it was expressed in somewhat ambiguous terms the pursuers wrote to the defenders on 3rd September, stating what was not included in their offer to the defenders. The letter contained the following statement:—"To prevent future misunderstanding, we beg to point out that the whole work expressly excluded from our offer, and which will require to be done by you, as follows:—Seat for dynamo and countershaft pulleys, belts, &c., required for dividing six iron brackets from which to suspend outside lamps, hooks from which to suspend portable lamps, whenever you wish to use them, wall boards where required for fixed lamps." By letter of 4th September the defenders replied to the effect that the pursuers had correctly stated the terms and conditions of the contract in their letter of 3rd September. The pursuers then proceeded with the work, and executed their part of the contract in a careful manner, with good materials and good workmanship. It was not part of their contract with the defenders that the pursuer should supply the engine or motive power for driving the dynamo machine. The defenders being unable to make arrangements satisfactory to themselves for driving the dynamo machine, were informed that the pursuers had a second-hand engine which they were willing to dispose of but that it had no governor, and would require to have one fitted. The engine was not purchased for some time after it was first spoken about; but on September 30th the defenders by telephone ordered it to be sent to them at the price charged in the pursuers' account, and instructed the pursuers to procure and fit to it a governor as cheaply as possible. These instructions were carefully and accurately carried out by the pursuers, and the engine forwarded to the defenders. The pursuers performed their part of the contract in a careful and efficient manner. The whole materials supplied by them to the defenders were of good quality, and they were fitted up by good workmen in a careful manner, and with good workmanship. The whole was handed over to the defenders in a condition capable of working well. If any defects subsequently appeared, these were not caused by any fault on the part of pursuers. The defenders did not provide for the dynamo machine and engine sufficiently stable or steady foundations. The seat for the machinery was supplied and erected by the defenders, and its instability was due to its situation in the defenders' premises, and to the site or situation having been chosen by the defenders, and to the nature and condition of the buildings in which the whole was erected. Further, the plant, after its erection by the pursuers, was not properly supervised by the defenders or their servants. Lord Low continued the case for the hearing of evidence.

Crompton and Company, Limited, v. Phillips Brothers—Phillips Brothers v. Crompton and Company, Limited.—These actions arose on a contract for lighting the town of Chelmsford with electric light, the plaintiffs in the first action claiming £3,000 damages from the defendants for breach of contract to supply insulated copper wire, while in the second Phillips Brothers sued Crompton & Co. for £1,405, the price of insulated wire sold and delivered.

The action was tried on Monday and Tuesday before Mr. Justice Day and a Special Jury.

Mr. Fletcher Moulton, Q.C., and Mr. J. C. Graham were for Crompton & Co.; Mr. Finlay, Q.C., and Mr. Archer Wallace were for Phillips Brothers.

Mr. GRAHAM, in opening, said the case arose out of a contract in which Messrs. Crompton undertook to light the town of Chelmsford with electricity, and in order to carry out the contract, they required a large quantity of wire. They applied to Phillips Bros., who eventually supplied about 60,000 yards of wire; the great bulk of that had been erected and found unsuitable, and it had to be taken down. Again, Cromptons having paid £1,000, claim to have that sum returned, and damages awarded. After the wire was put up, certain tests were made for the purpose of ascertaining whether that insulation was good enough for the purpose, and they found it very low, and after further tests, the wire was found wholly unsuitable, in consequence of which litigation commenced.

Mr. CROMPTON, who was called, said that after asking for quotations from Messrs. Phillips Bros. for B and C quality wire, they gave an extensive order for C quality wire. The wire had been supplied and hung on poles. In consequence of wrong working, they commenced testing the wires in September, and the tests, as a whole, came out very bad indeed, and the insulation resistance got steadily worse instead of better. They next commenced to test some of the wire which was still on the drums just as it had been received from Messrs. Phillips, and to their surprise they found that the wire was practically "rotten." They had paid sufficient to secure a first rate article for the purpose; in fact, it was the highest price paid for wire of this kind. They afterwards called in experts, who supplied reports on the defects of the wire. In his opinion the wire supplied was useless for any sort of electric lighting.

Mr. Justice DAY said the question for the jury seemed to be whether the wire answered the description of C quality wire.

Mr. MOULTON: Our case is that the wire is fit for no purpose, that it is leaky all over, that it is impure adulterated rubber, and the seams were unjoined. Or we have a further case; that it was not insulated wire at all, or not merchantable wire as C quality.

Mr. CROMPTON said, in his experience, the insulating material for wire used for town lighting should have been made of the best quality of rubber, and the price paid was ample to allow that being used.

Mr. Justice DAY: That is not the point. The question is whether it is merchantable C quality wire.

In cross-examination by Mr. WALLACE,

The PLAINTIFF said he did not order wire according to a sample. They gave an order for simply Phillips's C quality wire. They had used a large quantity of B wire. Their experience of B quality was it was very nearly though not quite equal to the requirements of Chelmsford Lighting, and they decided to go for a better and regular quality. He thought the makers guaranteed a specific resistance with C quality, but they had relied always on the good faith of the manufacturers. The test they carried out with the wire was with a Wheatstone bridge, and afterwards by the condenser method. Mr. Kempe also carried out tests for them, but as a rule they relied on the manufacturers.

Prof. JAMIESON was then called, and said that he had tested some of the wire supplied to Messrs. Crompton. The wire was certainly not sufficiently well insulated. Some years ago Messrs. Phillips handed to him a certain sample of C quality wire, which was certainly a different quality to that supplied to Messrs. Crompton. The sample that he had received was better.

Mr. H. R. KEMPE, electrician, Post Office, was the next witness called on behalf of the plaintiffs. At the beginning of 1890 he was called in by Messrs. Crompton to examine some wire. The wire had apparently not been used. It was coiled on the drums. He had the usual tests made by placing it in water, and the wire came out bad. He had examined several specimens cut from the faulty lengths, which had been used, and there were evidences of faulty manufacture. He did not consider insulated wire which had cracks was properly insulated. The rubber round the conductor was distinctly bad; it had none of the qualities of good rubber. The witness, in continuing, said, in order for wire to be properly tested, it was necessary that there should be a length of several yards. He considered the wire, as insulated wire, perfectly useless.

Cross-examined by Mr. FINLAY: He had never heard of any wire of this sort being employed for outside work. His experience did not go so far as that. He should think wire of that sort indoors would answer perfectly well as long as it was dry.

Mr. R. J. HATTON, Works Manager, Henley's Telegraph Works, said that he prepared for Messrs. Crompton a report of the tests of the wires. The chief defects were cracks in the rubber and imperfect joining of the seams which ran more or less all through the wire. He would certainly not describe it as merchantable wire.

ROBERT FRANCIS HAYWARD, Electrical Engineer Manager, of Crompton's Works, Chelmsford, in his evidence said that he had two interviews with Mr. Reed, Messrs. Phillips's traveller. He told him that they required a great quantity of wire for lighting Chemlsford. He explained to him that the wire would be required to be hung on poles for street lighting, and to bear a pressure of at least 2,400 volts. He also discussed the question of quality, and Reed told him that pure rubber was not so good as vulcanised rubber for insulation. It was therefore arranged that vulcanised rubber should be used. He did not recollect anything being said at that time about C quality.

Cross-examined by Mr. FINLAY: He did not recollect that Mr. Reed showed him a specimen of their C wire. He would swear that he said it was required for outdoor purposes and for a voltage of over 2,000 volts.

Mr. ROOKE, Storekeeper at Crompton's, corroborated the last witness's evidence as to the interview.

Mr. FINLAY, in addressing the jury, said they had surely by this time appreciated the question which remained to be tried. He did not think they were very much indebted to their learned friends the counsel, on the other side; there had been a decided want of elucidation on their part. They had shown a tendency to lead to questions which were perfectly alien to the subject before them. His friend, Mr. Graham, had questioned the witnesses over and over again as to whether this was a merchantable insulating wire, and he had given them a series of figures about the number of megohms which the insulated material of this wire showed per mile. He hoped the gentlemen of the jury perfectly realised that in this matter Messrs. Crompton were perfectly familiar with the defendants and with their course of business. Mr. Graham had said that it was only the defendants who knew what the C quality of wire was. He thought all would agree with him that before Mr. Crompton instructed those in his employ to order C wire Mr. Crompton must have known what the C quality was. He was a gentleman of some experience in these matters, and dealing with the defendants some time, it would be surprising if C wire had been ordered without there being a knowledge of what it was. If they wanted to have a properly guaranteed insulation they must pay for it, and it was perfectly well known that the defendants did not guarantee the class of wire purchased by Messrs. Crompton. The only quality guaranteed was what is known as the D quality, for which a higher price had to be paid. This was perfectly well known to Messrs. Crompton. He (Mr. Finlay) did not know if the Chelmsford electric lighting was a very remunerative enterprise, but, at all events, Crompton's did not consider the margin of profit sufficient to allow them to pay the price that would be necessary for a guaranteed wire. If wire was only to be used indoors and not exposed to wet they did not want a perfect insulation, and they did not want a guarantee of insulation. He hoped they appreciated that insulation is the question in this case, they were not dealing with the resistance which the copper wire itself presented to the passage of electricity along the wire. They were dealing with the resistance which the insulating material round the wire presented to the escape of the electric forces which was passing along the wire from the centre of the insulating material. No insulation could be absolutely perfect. In the best insulation they must have in a long extent of wire a certain amount of leakage, and the longer the wire the greater the chance there is of a certain amount of escape. When they wanted a wire which was to be exposed to wet they told the manufacturers that they must have a wire which had a certain amount of insulation, and they bought a wire such as Messrs. Phillips's D quality, with a guaranteed insulation, but they had got to pay for that. Messrs. Crompton had not had that, although they knew perfectly well what C quality wire was. They asked for a quotation of B and C quality, both perfectly suitable for the purpose for which they are used, but having ordered C wire, what did they do but apply it to a purpose to which, according to admission of the witness called on behalf of the plaintiffs, the C quality wire had never before been used. C quality wire was perfectly suitable for the purpose to which it had been applied, namely, indoor work, till Mr. Crompton made this experiment at Chelmsford. Where it was not exposed to damp it is perfectly suitable, and everyone who knew Messrs. Phillips knew that perfectly well. Of course if they took wire and placed it out in the open air they had to take their own risk. They also applied it to another use, and that was using a voltage of upwards of 2,000 volts. Wire of this kind had never before been exposed to such a voltage. Mr. Reed, the traveller, would be called before them, and he submits that a great deal of the conversation which my friend Mr. Graham got from Mr. Hayward was totally inadmissible for the purpose for which his friend desires to use it. Mr. Reed would absolutely deny that this conversation took place. He would call witnesses who would tell them that this C wire was perfectly fit for use under the conditions which C quality was universally acknowledged.

GEORGE RUSSELL REED was then examined on behalf of the defendants, and denied that any conversation ever took place with Mr. Hayward on the subject of the wire.

Mr. CHARLES PHILLIPS (of Phillips Brothers) said that D quality was the only wire which they guaranteed. They had never on any occasion guaranteed C quality. C had only been used for indoor work and for 100 volts pressure. He certainly would not recommend it to any of his customers for outside work, and for a high pressure of 2,000 volts. Large quantities of C wire were sold and approved of generally.

In cross-examination he admitted that wire which had a good number of cracks in was not good C quality, but he did not make himself responsible when sending out C wire because they never tested it. He remembered receiving a telegram from Messrs. Crompton's asking what the insulation resistance of C quality was, although he was away at the time; he remembered that a test was made of a short length that they had in the place, which said piece gave a resistance of 250 megohms. They wired to Messrs. Crompton saying that they had made a rough test, giving the result stated. He would not guarantee that C quality had not holes. The witness further stated that Messrs. Johnson and Phillips made this particular wire—they did not make it themselves. They had made large quantities of C quality wire for them. He did not give any special instructions with respect to making the C quality.

Mr. MASSEY, electrician to the Queen's Household, was next called, and said that he did not think C quality was fit for the purpose to which Mr. Crompton had applied it. He had used large quantities of C wire and had never noticed cracks or seams, but he would not be surprised to hear that there were.

After the examination of Mr. Esson and Mr. Storr,

Mr. FINLAY addressed the jury on behalf of the defendants. He said he would endeavour to bring the case to a point, and clear up some matters which he submitted to the better judgment of the jury. His friend, Mr. Graham, in his very skilful cross-examination, had shown a great tendency to evade the point. The real issue in the case was this. Was Mr. Crompton entitled to complain after the defendants had supplied to him a wire which had not the insulation which he said he was entitled to, and were the defendants liable for having supplied to Mr. Crompton a wire of inferior insulating power? Mr. Graham had a strong predilection for asking about cracks and open seams, which he suggested, according to his evidence, might exist in the specimens produced. He decided, in regard to the matter, to make two observations for their consideration. The first was, if they took the cheaper article, which was not guaranteed, they must, in the very nature of things, expect that there would be cracks and some defects. If they wanted a superior article, they must pay a higher price, and get their guarantee. They must expect that there would be some defects in wire of a cheaper kind, but it does not cease to be merchantable because of the existence of such defects. He wished to point out that it would be very unfair indeed to accept the examinations made by the plaintiffs' experts after the wire had been used and handled for a very long time. This wire was supplied as long ago as the summer of 1889. Since then a very large part of this wire had been in use for two years. 35,000 yards were actually in use still, and if the wire had been handled and used, it would be very unfair to say, because under these circumstances some cracks and defects might have developed, then therefore the wire was not fair merchantable C quality when delivered. It did not matter much that the insulator was of an inferior power, that it does not come up to 100 or 200 meghoms, if the conditions under which the wire is to be used are such as not to call for a high insulator. C quality had always been used where high power insulation was not required. The whole mischief had arisen because Cromptons had been using this wire for outdoor purposes, where it was exposed to a large amount of wet. He respectfully submitted that Cromptons were not entitled to come forward with a complaint, when they chose to buy a cheap wire and use it in a place for which it was never intended. If they bought wire which was ordinarily used for one purpose, and used it for another, they really could not complain if the wire turned out unsatisfactory, and if wires which are intended for low voltage were used for a high voltage of 2,000, they are subjecting the wires to conditions for which they were not made.

Mr. GRAHAM, on behalf of the plaintiffs, said when the contract was entered into by Cromptons, in 1889, it was clear beyond a doubt that Crompton was not asking for an expensive insulation resistance. What was wanted was a wire which could fairly be used for electric lighting, but he did not get a wire of this kind. There was not the slightest doubt, it was admitted, that the wire had defects. It was not until this litigation was begun that Messrs. Phillips said that the wire was unfit for the open air. The wire which Phillips supplied was vulcanised, and the mere fact that the wire was vulcanised showed that it was intended for the open air.

The JUDGE then summed up. In the contract made, C quality was asked to be supplied, therefore it ought to be a merchantable C quality. It was, therefore, important what C quality meant. I suppose the plaintiff when he ordered the wire knew what it was, but when the plaintiff's case was closed he knew nothing about it. All the defendants' witnesses said they would never have dreamed of using C quality for out of doors or for such high voltage. However, the matter rested with the jury.

The jury, after being absent from court an hour, returned a verdict for the plaintiffs, but expressed an opinion that the plaintiffs had been negligent in not ascertaining what C quality was.

After some discussion, it was agreed that the question of damages should be referred to Mr. Kempe on the one side and Mr. Massey on the other.

PARLIAMENTARY NOTES.

NEW RATES FOR FOREIGN TELEGRAMS.

In accordance with the arrangement accepted by the International Telegraphic Conference recently held at Paris, the Postmaster-General has issued a notice to the effect that on and from July 1st the rates for telegrams to certain countries, hereafter named, will be reduced. Thus telegrams to Austria-Hungary, and Italy, which have hitherto been charged at the rate of 4½d. a word, will be reduced to 3d., and those to Gibraltar and Portugal, now rated at 5½d., will be charged 4½d. a word. Telegrams to Malta, for which 7d. is now charged, will then be 6d.; while the rates for Sweden and Norway, now respectively 5d. and 4d., will be reduced to 4d. and 3½d., and to Russia from 6½d. to 5½d. a word. The reduction as regards Spain and Switzerland will be from 4½d. and 3½d. to 4d. and 3d. respectively. In respect of the Canary Islands and Java the rates descend from 1s. 7½d. and 6s. 10d. to 10d. and 6s.; and from Singapore and Penang they drop from 6s. 5d. and 5s. 7d. to 5s. 9d. and 5s. To Senegal the present rate of 2s. 10½d. will be reduced to 1s. 6d.; and to St. Paul de Loanda the charge, 9s., will now be 8s. 7d. per word. At the same time, the fee for signalling ships at foreign semaphore stations will be reduced from 1s. 8d. to 10d.

THE POST OFFICE AND THE TELEPHONES.

In the House of Commons, last week,

Dr. CAMERON asked the Postmaster-General whether the patents for the more important telephones in use in this country expired in July next; and, if so, whether he was now in a position to announce the decision of the Post Office as to granting licenses for telephone exchanges to applicants proposing to introduce loud-speaking and other improved forms of the telephone?

Mr. RAIKES replied that it was a fact that one of the more important patents expired in July. The question of the relations of the Post Office and the telephones was one of great complexity as well as of great importance. It was more than a departmental question. The subject had been occupying the anxious attention of the Government, but they had not yet come to any arrangement as to the course to be pursued.

Dr. CAMERON said he would repeat the question in the course of a couple of weeks.

Mr. RAIKES said he would be very glad to give any information as soon as he was in a position to do so.

BIRMINGHAM CENTRAL TRAMWAYS AND THE USE OF ELECTRICITY.

The Select Committee of the House of Lords, presided over by the Duke of Westminster, sat again last week, and proceeded with the consideration of the Bill confirming the Provisional Order which authorises the Birmingham Central Tramways Company to work their cars generally by electricity.

Sir HENRY MANCE, chairman of the Electrical Construction Corporation, was called on behalf of the tramways company. He said that he did not think that the tramways company would be able to lay down the extra conductor for the return current at less than £1,500 per mile. On the other hand, the Telephone Company could double their system of wires at an extra cost of about £5 per mile. The telephone company would not, however, be obliged to double their whole system, but only in the neighbourhood of an electrical disturbance.

Cross-examined: He thought external haulage was cheaper than accumulators, and he preferred overhead wires for the purpose; but, of course, that would not be allowed in this country.

Sir JOSEPH KINCAIRD, joint engineer to the Birmingham Central Tramways Company, said that he had carefully gone into the cost of laying the conduit for the electrical conductors. If there were one conductor the cost would be £1,760 per mile, and for two the cost would be £2,410 per mile. He considered it only fair that the telephone company should protect themselves, and at the same time improve their service, by doubling their system, instead of requiring the tramways company to incur a very considerable additional expense.

Mr. BALFOUR BROWNE, Q.C., in addressing the committee in support of the Bill, and against the clause which the telephone company asked to be inserted, said that the latter were trying to do an exceedingly impertinent thing, inasmuch as they were trying to relieve themselves of a certain outlay, and put a quite unnecessary expense upon the tramways company. To a large extent the telephone company in Birmingham were only there upon license, and some portion of their tenure existed only on seven days' notice. At any time the telephone company could have notice to leave, and then if this clause were put into the Bill, what would be the result? An enormous expense, amounting to about £66,000, would have been incurred by the tramways company for the telephone company, who would be bag and baggage away from Birmingham. Was that a thing to be listened to for a moment? The remedy was obviously not to put the cost upon the tramways company, but upon those people who wanted protection Let them do it themselves. But even if the tramways company was obliged to lay out this large sum, the evil complained of would not be remedied, and ultimately the telephone company would have to duplicate their wires, just as if the extra conductor had never been laid.

Mr. E. O. SMITH (Town Clerk of Birmingham) was called in support of the corporation's objection to the clause being inserted. After describing the relations between the corporation and the tramways company, he said that under existing orders the latter had powers enabling them to use electricity. The present order authorised a small extension of the existing system by about an eighth of a mile, and it seemed to him, therefore, rather hard that upon such a small extension the telephone company should come and object to the use of electricity along the whole line. Birmingham having an essentially artisan population, it was of great importance to have cheap and ready means of transit, and the corporation had done all they could to encourage that.

Cross-examined: There was a very general desire to replace the use of steam by electricity, as the former in many respects was a great nuisance in the thoroughfares. The engines were unsightly and hideous, and complaints were made of the smoke.

Mr. POPE, Q.C., addressing the committee on behalf of the Birmingham Corporation, said that if the restrictions which the telephone company asked were placed upon the tramways company there would be an end of electrical traction so far as Birmingham was concerned. That, the corporation considered, would be a great misfortune. They further considered that it was unfair for the telephone company to take the present opportunity to try to put upon the public of Birmingham—for upon them it would be—an obligation of the kind suggested. The tramways company were now only asking for a very small length of additional tramway. They had already power to use electricity without restriction, so that it was rather hard for the telephone company now to come and ask for the imposition of restrictions.

Mr. FLETCHER MOULTON, Q.C., on behalf of the telephone company, urged that the claim put forward by his clients was moderate and just. At the first opportunity they had come and asked for the protection of their lawful business. Referring to precedents, the learned counsel contended that they supported him in his demand for the clause. No doubt the corporation spoke truly when they said they desired to have cheap fares. But that was no reason why the telephone company should be mulct in an extra expenditure of about £20,000, in consequence of the tramways company doing their work in a careless manner, and allowing the electricity to escape. It was a speculative thing as to whether the system now talked of would be adopted. There were plenty of other methods, and in any event the tramways company should be bound to refrain from injuring others around.

The room was then cleared whilst the committee deliberated in private.

Upon the parties being readmitted,

The CHAIRMAN stated that the committee were of opinion that a clause should be inserted for the protection of the telephone company, similar to the one in the West Metropolitan Act.

THE CENTRAL LONDON RAILWAY BILL,

which was thrown out by a Committee of the House of Lords, and which this session has been sanctioned by the House of Commons, came on Tuesday, before a Committee of the House of Lords, consisting of the Earl of Elgin (Chairman), Earl of Mar, Lord Saltoun, Lord Manners, and Lord Alcester.

Mr. PEMBER, Q.C., in opening the case on behalf of the promoters, said that the only opponents now appearing by counsel were the Vestry of Marylebone, frontagers along the line of route, and Mr. Maurice Powell, the owner and occupier of No. 2, Kensington Palace Gardens, who appeared in person. The learned counsel went on to say that in making the line they would not interfere with the streets, that all vibration would be avoided, and that all nuisances arising from smoke and so on would also be done away with. The line would run from Shepherd's Bush to Cornhill, with 13 stations on the way, all conveniently situated. The speed at which the trains would be run was 25 miles an hour, inclusive of stoppages, which would work out at about 25 minutes for the entire journey, or about 25 per cent. quicker than the speed at which the trains ran on the Inner Circle. Since the Metropolitan Railway had been constructed, 25 years ago, the increase in the traffic of the streets of London might be calculated to be over 700 per cent. It was established beyond a doubt that some means must be devised for getting rid of the present congested state of the traffic, and the only way of doing so was by a new line on the same principle as the Metropolitan, an overhead railway, or the one proposed by the Bill. The capital required was a little over £3,000,000, and the engineers of the scheme were Sir John Fowler, Sir Benjamin Baker, and Mr. Greathead, of whom the last-named had carried to a successful issue the City and South London Electric Railway, which, during the six months for which it had been opened, had carried three millions of passengers, and where, so far as electric traction was concerned, there had never been a hitch.

Evidence having been given by Mr. GREATHEAD, the engineer of the line, Sir B. BAKER, C.E., Dr. HOPKINSON, electrical engineer, and Sir FREDERICK BRAMWELL, C.E., the case in support of the Bill was concluded, and the committee adjourned until the following day.

Mr. HAMILTON SMITH, managing director of the Exploration Company, by whom a syndicate has been formed for raising the capital necessary for carrying out the undertaking, then gave evidence. That the system of electrical traction was successful, he said, had been proved in the case of the City and South London Railway, and that the proposed line would be a financial success he felt certain, speaking from his experience of the growth of street traffic on similar lines in the cities of the United States. He calculated that the Central London would carry from 25,000,000 to 30,000,000 passengers a year at first, which in the course of five or six years would probably be increased to 50,000,000 or 60,000,000. The chairman then announced the decision of the committee that the preamble was proved, but they declined to insert the clauses asked for by the Vestry of Marylebone.

The Examiner of the House of Lords had before him on Monday last, and found that Standing Orders had been complied with in the case of, the Provisional Orders giving power to the Brush Electric Engineering Company, Limited, to supply electricity for lighting purposes in the City of London, Clerkenwell, and St. Luke, Middlesex; to the New Cadogan and Belgrave Electric Supply Company, Limited, to supply electric light in St. Luke's, Chelsea; and to the Woolwich District Electric Lighting Company to supply electric

lighting in Woolwich. Power is also given to lay distributing mains within a period of two years in Fleet Street, Ludgate Hill, Bridge Street, Farringdon Street, Holborn, Holborn Viaduct, Newgate Street, Charterhouse Street, King Street, Long Lane, Snow Hill, Chancery Lane, Fetter Lane, St. Andrew's Street, Shoe Lane, St. Bride Street, Old Bailey, and St. Paul's Churchyard, in the City; in Clerkenwell, St. James and St. John; in the Goswell Road; in St. Luke's, Chelsea; in Manor Street, Cheyne Walk; Chelsea Embankment, Tite Street, Tedworth Street, from Tite Street to Ralston Street, and from Ralston Street to Redesdale Street; in the last-named street, from the north-east corner of Tedworth Square to Smith Street; in Smith Street, from Redesdale Street to King's Road; in King's Road, from Smith Street to Sloane Square; and from Oakley Street to Church Street, Cadogan Gardens, Cadogan Square, Pont Street, Hans Place, from Pont Street to York Street, along the west and north sides of Hans Place, Lennox Gardens, Milner Street, from the south-west corner of Lennox Gardens to Cadogan Square; Walton Street, from the west end of Pont Street to the south end of Beauchamp Place; Oakley Street, Sloane Street, Sloane Square, Cadogan Place, Lowndes Square, and Fulham Road, from the north-east corner to the north-west corner of Elm Park Gardens; Elm Park Gardens, Elm Park Road, and Church Street from King's Road to Elm Park Road; and in Manresa Road from King's Road to the New Free Library. In St. Luke's, Middlesex: in Apple Yard, Bunhill Court, Charles Court (Hull Street); Lewen's Court, New Court (Middle Row); Oliver's Yard, Osman's Place, Phœnix Place (Old Street); President Mews, Thomas Place (Middle Row); Waterloo Place, Wellington Place, Whitby Court, York Mews, and Three-King Court (Whitecross Street); and in Woolwich mains will be laid in that portion of High Street which lies between its junction with Glass Yard and Beresford Street, Hare Street, Powis Street, from its junction with Hare Street to Green's End, William Street, from its junction with Powis Street to the Town Hall, Beresford Square, Plumstead Road, from Beresford Square to the eastern boundary of the parish, New Road, from Beresford Square to its junction with Thomas Street, Green's End, Thomas Street from New Road to Wellington Street, and in Wellington Street from Green's End to its junction with Lower Market Street.

ROYAL AGRICULTURAL SOCIETY'S SHOW.

AT the annual show of this society, held during the present week on the celebrated racecourse at Doncaster, there was from the electrical point of view even less of interest than there was at Plymouth last year, or at Windsor the year before. In fact, the only electric exhibit was at the stand of the Priestman Oil Engine, where one of these engines (of the portable type) was shown driving a Holmes's "Castle" dynamo which fed a number of incandescent lamps in the enclosure. These engines are coming extensively into use for country house lighting, one of the latest instances being in the neighbourhood of the show, at the residence of Colonel Saltmarsh, at Saltmarsh, where an installation of 70 lamps is run off a Holmes's dynamo, driven by a Priestman oil engine. At an adjoining stand a new oil engine is shown by Messrs. R. Hornsby and Sons. The Hornsby-Akroyd engine is said to be the first ever put upon the market which uses oil of the specific gravity of ·850; in fact, the oil used is a lubricating oil, so that there is not the least danger attending its use. The engine has no slide-valve, and does not require any igniting tube or electric spark, a simple lamp burning the comparatively heavy oil used in the engine, being employed for a few minutes when starting, after which it is entirely dispensed with. The engine is then perfectly automatic, and will work continuously and regularly without attention so long as there is oil in the cistern, the governor regulating the supply of oil according to the variation of work required of the engine.

There was a good show of gas engines, including the Stockport, which experience has proved to be thoroughly satisfactory in "connection" with electric machinery, the Fielding, and the new electric lighting Otto.

Although there was nothing particularly novel amongst the steam engines, the usual excellent displays made by the following firms included several to which attention was called on the ground of their being well adapted for driving dynamos. Messrs. Robey showed a compound 6 H.P. short-stroke stationary engine, in which the bed-plate, cross-head guides, and crank-shaft brackets are all cast in one piece, the cylinder, with its valve chest, being bolted to the end of the engine frame; Messrs. John Fowler & Co., a horizontal engine, 12-inch cylinder, with automatic expansion gear controlled by the governor, and especially adapted for steady running; Messrs. Marshall, Sons & Co., two horizontal engines and one vertical, all designed for driving electric light and similar machinery; and Messrs. Ransomes, Sims and Jefferies a 10 H.P. compound "Undertype" engine, fitted with patent automatic governor expansion gear, rendering it specially suitable for electrical purposes.

Messrs. W. H. Willcox & Co., had a prominent exhibit of lubricants, hose, belting, tools, and engineers' sundries.

Davey Paxman & Co., Engineers, Colchester, exhibit one of their compound portable engines and one of their single cylinder portable engines. These have again been selected by the Royal Society for carrying out the trials of the threshing machines.

Our readers will doubtless remember that Messrs. Davey Paxman & Co., after competitive trials (open to all makers), held at the Royal Agricultural Society's show at Newcastle-on-Tyne, in July, 1887, were awarded the only prizes offered, viz.—£200 prize for best compound portable engine, and the £100 prize for the best single cylinder portable engine. These awards were given for great efficiency, extreme economy in fuel and steam, and the general excellence in design and workmanship, the judges in their report saying:—

"The trial of this engine was characterised by perfect smoothness of working and great regularity of speed, the governor having perfect control of the engine."

One of Davey Paxman & Co.'s 10 H.P. portable engines can also be seen driving one of Marsden's stone breakers at Stand No. 223.

NOTES.

Electric Omnibuses.—We have received a lengthy letter from Mr. Radcliffe Ward on the subject of electric omnibuses; it came in, however, too late for insertion in this issue.

Three Labourers Killed by Lightning.—A despatch from Losing, in the Odenburg district, states that 18 field labourers, having been overtaken by a thunderstorm, sought shelter by the side of a hay rick, which was immediately afterwards struck by lightning. Three of the men were killed on the spot, the others being stunned by the electric discharge.

Electric Lighting in the City.—The examiner of Bills for the House of Lords has reported that the standing orders have been complied with in connection with the City electric light Bills.

Meter Registration.—It has been stated that the majority of consumers of electric current prefer to have their consumption registered on meters with dials rather than by the voltametric method. A customer can read a dial; a voltameter is an unfathomable mystery; consequently, if the dial shows 1,000 watts, the real consumption being, perhaps, much less, he will rather pay the increased amount than trust to the more correct instrument he does not understand. That man is like unto those who borrow money (nominally at the same rate of interest in either case) from a money lender, instead of going to their lawyer, but forget to observe that the money lender's 5 per cent. is *per mensem*.

Mutual Telephone Company.—The number of subscribers on this company's Manchester exchange actually speaking on June 19th, was 366. They are being added to daily at the rate of 25 per week. The progress made might be quicker, but it is not desired to have more than 500 talking on July 30th, as after that date the magneto transmitters now being put in are to be replaced by carbon ones. We understand that the Mutual Company will be prepared on July 31st with a sensitive and efficient transmitter, made in accordance with one of the designs figured in Edison's tension-regulator patent, which expires on July 30th. Arrangements are being made to join up 50 subscribers per week after the change of transmitters has been effected, and erect trunk lines to, and open exchanges in, Bolton, Oldham, and many of the other Lancashire towns.

The Central London Railway.—We note with satisfaction that the preamble of the Central London Railway Bill passed the House of Lords Committee on Wednesday last. Last year the measure was thrown out by a committee of the Upper House, after it received the approval of the Commons, principally on the ground that no experience had yet been gained with electricity as a motive power on underground railways. This objection has been removed by the promoters proving that the working of the City and South London Railway has been satisfactory.

Obituary.—W. E. WEBER.—The news comes from Berlin that the eminent natural philosopher and experimentalist in physics, Prof. Weber, has died at Göttingen, at the age of 87. He was the inventor of the electro-dynamometer, and was regarded in Germany as the real inventor of the electric telegraph. Working together with the famous mathematician Gauss, he tried to establish a means of communication between the latter's observatory and his own laboratory, and in this way in 1833 came upon the invention of the electric telegraph. But neither comprehended the extraordinary importance of their invention, and thus others were generally regarded as the inventors of the telegraph, although they were anticipated by Weber by several years. Weber has written many papers on magnetism and electro-dynamics, and may be considered the founder of the present system of absolute measurement.

Silver Peroxide by Electrolysis.—As long ago as 1873, W. Hampe, a German scientist, obtained a crystalline deposit upon the positive electrode when electrolysing a concentrated solution of silver nitrate. A quantity of this substance was put aside in a sealed tube for future reference. In this state it remained for several years, and then the tube suddenly exploded violently. Hampe has been investigating this curious substance and its curious behaviour. He finds that the electrolytic deposit evolves a quantity of oxygen when placed in contact with water, and doubtless it was owing to some sudden evolution of the gas that the tube exploded. The substance is probably a peroxide of silver, but it is not pure, and contains a quantity of silver nitrate, from which it appears to be impossible to free it. In fact, the crystallising electrolytic deposit is probably a mixture of silver nitrate, silver peroxide, and some water of crystallisation.

Employés Patent Rights. — The American Brush Electric Company has been sued by one of their late *employés*, a Mr. Pfannkuche, who claims, for an alleged breach of contract by the Brush Company, the modest damages of $150,000. The plaintiff claims he contracted with the company to develop a certain system of incandescence lighting, and was to assign to them all title to inventions made while in their employ; that he assigned to the company ten patents in one year, and twelve in the next. But when it was notified that the prolific inventor's services were no longer required, "the pique began." Can Mr. Pfannkuche be any relation to the gentleman of similar name, formerly residing in this country, who will long be remembered by two of the emanations from his fertile and ever-scheming brain? One was commonly called the *Geyser or Volcanic* resistance box, because when in use it threw off dense clouds of smoke or steam. A rumour got abroad at the time that one of his assistants discharged a bucket of water over the box thinking it was on fire. The second invention was a method of propelling war-ships, comprising a combination of huge cylinders fitted within the vessel, kept charged with pease pudding or other gas producer of rapid action, together with a tube leading from the cylinders to a hole or vent in the stern of the ship, whereby the generated high pressure gas could be expelled, this back pressure to produce a powerful motive force. If the Mr. Pfannkuche who is bringing the action against the Brush Company is not a relative of the above ingenious inventor, he, at least, shows by his inflated claim that he is imbued with the light and airy nature of his namesake.

Street Lighting.—The Chairman of the Carshalton Local Board requires tenders for the lighting of the district by gas, oil, or other means; Mr. James Manley, High Street, clerk. Cleethorpes (Grimsby) is in want of similar estimates; Mr. B. Greaves, clerk.

The Electric Light in the City.—Queen Victoria Street was lighted entirely by electricity for the first time last night. It was, however, only for the purpose of affording the Commissioners of Sewers an opportunity of inspecting the effect of the electric lighting of the street by means of 26 arc lamps installed by the Brush Company.

Automatic and Multiplex Telegraphy. — Mr. Gisborne's paper on the above theme, read before the third section of the Royal Society of Canada at its meeting in this city (Ottawa, Canada) last month, is of sufficient importance for further notice. He showed, in his usual clear and incisive way, that late improvements have rendered it quite possible for the telegraph to compete successfully with the postal service, thus emphasing the frequently expressed opinion that the time is ripe for the combination of both services in the hands of the Government. The Hon. Mr. Wanamaker, Postmaster-General of the United States, has taken the initiative in this matter, and the experience gained already justifies the course adopted some years since by the British Government. Mr. Gisborne stated that three thousand words per minute had been transmitted by a round-about copper-wired line, 355 miles in length, between New York and Washington, and 800 words over a similar wire 1,000 miles in length, between New York and Chicago, and that 600 words per minute have been transmitted by repeaters beyond that distance. As a sequence to his paper upon "The Inception of Electrical Science and the Evolution of Telegraphy," read before the Royal Society five or six years ago, and printed afterwards by "The Canadian Society of Civil Engineers," Mr. Gisborne proved that the most successful telegraph companies of the future will abandon their present system of a multiplicity of wires for one or two now sufficient to transmit the entire business of Canada between every important centre, with time enough and to spare. He also proved that by the late inventions which he described, a message of a hundred words could be transmitted for 25 cents at a large margin of profit for 1,000 miles distance, and finally showed, by statistical information received from the telegraph companies and the postal service, that the business was ready to hand for the accomplishment of his estimates. Prof. Barker, of Philadelphia, and other gentlemen in the room, expressed their opinion in no uncertain manner as to the practical importance of Mr. Gisborne's views, and the novelties of the inventions to which he referred. We hope the Royal Society will permit the publication in full of Mr. Gisborne's paper in advance of the issue of their next year's volume of proceedings. Of the two inventions described, one is an American patent, and the other a Canadian. An era of cheap telegraphy seems at hand, when 25 cents will pay for a message of 100 words, a rate that will abundantly remunerate the companies using the new systems.—*Montreal Gazette, June 13th.*

The Electric Light at Southampton.—At the last meeting of the Southampton Pier and Harbour Board the Special and General Works Committee reported that they had received the draft form of agreement with the Southampton Electric Lighting Company prepared by the company's solicitor, and revised by that of the board, for the supply of electricity for the working of cranes and the lighting of quays, &c., the arrangement being proposed to be for seven years, the board guaranteeing a minimum payment of £200 per annum. The committee recommended the adoption of the agreement. Objection was taken to binding the board for seven years, and an effort was made to reduce the term to four years. A question was also raised as to the utility of electric cranes. On a division, an amendment to reduce the term to four years was carried. A question then arose whether the company would consent to this alteration, and eventually the matter was adjourned.

The E.P.S. Batteries.—The Electric Construction Corporation, Limited, informs us that arrangements have been made with the Foreign and Colonial Electrical Power Storage Company, Limited, by which the storage battery business at home as well as abroad has been transferred to them. The manufacture of E.P.S. batteries will be continued at the Millwall Works as heretofore, under the superintendence of Mr. Frank King, who has been so long associated with their development.

Dover Lighting.—Tenders are required for the execution of and maintenance of works needed for the supply of electricity within the borough, for the corporation of Dover. Copies of the conditions can be obtained, and the provisional order and deposited plan inspected at the office of Mr. E. Wollaston Knocker, Town Clerk.

Railway Safety Appliances. — Messrs. Saxby and Farmer have issued a supplement to the 4th edition of their valuable work on Railway Safety Appliances, giving an interesting description of the Bianchi and Servettaz system of hydraulic working and interlocking of railway points and signals. Hitherto the hydraulic system of working points and signals has been considered somewhat unreliable, the danger being that through leakage or accidental obstruction the tongues of the points might not close properly, while the signalman would remain in ignorance of the defect. The essential feature of the new system is that such difficulties are overcome by means of a return pipe, which provides return pressure from the points to the point lever in the cabin, constituting an infallible detector. After careful consideration and practical testing, Messrs. Saxby and Farmer are convinced that, with the Bianchi and Servettaz improvements, the hydraulic system is now rendered in practical railway working as safe, as simple, as durable, and as altogether reliable as any other system yet known. The value of this achievement lies in the fact that the hydraulic system can be installed in situations and under circumstances which render any other system impracticable. A full-size working installation of the Bianchi and Servettaz apparatus has been erected at Messrs. Saxby and Farmer's works at Kilburn, for inspection by railway directors, managers, and others interested.

City and South London Railway.—The *Financial News*, in a leading article on English railways, says of the South London Railway: "The progress of this undertaking is being watched with no common interest. If it can be made to pay fair dividends it suggests a possible solution of this ever-growing difficulty of congested thoroughfares, which threatens, one of these days, to break down our whole system of internal communication. The gross receipts appear to average about £800 a week, so that the income of the company will be £40,000 a year. The chairman, at the meeting held on Tuesday, calculated that, after payment of all working and administrative charges, this would leave a profit of £12,000 per annum, which would be sufficient to meet the debenture interest and leave a margin of from £3,000 to £4,000. He hoped that during the next twelve months it would be possible to increase the receipts and lessen the expenditure, and thus secure a small dividend for the ordinary. The line is yet, however, quite in the experimental stage so far as financial considerations are concerned. Everything appears to depend upon the elasticity of the traffic, and to what extent the number of passengers can be increased is a problem which only experience can determine. It is not likely that investors will find capital for enterprises of this kind unless they can see a fair chance of getting an adequate return for their money. The South London line unquestionably deserves success, and if it obtain it, a big step will have been made towards dealing with the dense and confused traffic of the London streets. Electric railways are now in the probationary stage. That they will grow by-and-bye in popularity there can be little doubt; but until the financial results are placed beyond the reach of question no bold and comprehensive plan for a system of underground relief seems at all likely."

The Electric Railway of To-Day.—This is the title of a small American work of some 60 pages on electric railways. The subject is presented in a popular manner, and it deals successively with the power station, the electrical apparatus, the switchboard, line construction, the car motor, &c. It is excellently illustrated with capital reproductions of photographs of American lines, and with diagrams explanatory of the working of various systems. There is also a list of American electric tramways in operation and in course of construction up to date of May 1st; these number no less than 250. The author of this entertaining little volume is Mr. H. B. Prindle, and copies may be obtained from the office of the ELECTRICAL REVIEW for 2s. 6d., post free.

Electrical Exhibition.—At a *conversazione* of the Royal Medical and Chirurgical Society, 20, Hanover Square, on the 23rd inst., at which nearly 2,000 of the leading doctors of the United Kingdom were present, Messrs. Rashleigh Phipps and Dawson, of 53, Berners Street, W., gave a most interesting exhibit of electrical and other appliances. Amongst many novelties may be mentioned the following:—Small incandescent lamp for examination of mouth and teeth and looking right down throat; electro-magnet for removing fragments from the eye; electric dental drill; larynx lamps; incandescent lamp, with holder for microscope; physicians', practitioners', and patients' batteries; galvanometer; Cautery battery with rheostat cauteries and handles; new form of photophore battery; a lantern worked by 100 C.P. lamp, throwing many interesting medical subjects on to a large screen; Edison's phonograph; the gramaphone; electric cigar lighters; new patent speaking tubes, &c. The rooms were most brilliantly lighted by electric light, the current being supplied from the plant installed on the premises by Rashleigh Phipps and Dawson. A most exquisite effect which was got by festoons of coloured ray diffusers, dispersed here and there, with large silk shades, being hung down the central corridor and round the large hall, excited universal admiration. This form of electric lighting will doubtless become very popular for temporary lighting purposes.

A Retrograde Step.—The Barnet Local Board has determined, so it is reported, to discontinue the public lighting of their district by electricity and to revert to gas as a street illuminant, the step being the result of a three years' trial of the former. The cost of the electric lamps, on the basis of light for light, was represented to be slightly lower than that of the gas lamps, but as nearly as many 32 candle-power lamps (at a figure approaching double the cost) were used as the 15-candle-power lamps they were intended to replace, the net result of the adoption of the electric light was considerable increase in expenditure. This might have been tolerated had the board been satisfied that their district was better lighted, but they became doubtful on the point, and obtained the services of an expert, who reported that, while a few lamps exceeded their nominal power, the bulk of them were far below it, a few being little over 12 candle-power, or from two to three candle-power below the old gas lamps. Then, too, the lighting was irregular, and on several occasions the lamps suddenly went out altogether, leaving the streets in total darkness; on one occasion the inconvenience thus caused was so great, that the clerk to the local board found it necessary to make temporary arrangements with publicans, shopkeepers, and private residents to show gas and other lights in their windows, and (where practicable) outside their premises. Recently, as an experiment, the local board has arranged to have a powerful arc lamp at the entrance to the town; but this has been very erratic in its behaviour, and at length the board, to the evident satisfaction of the bulk of the residents, has determined to abandon the system altogether.

Messrs. Joel & Co. inform us that the recent tender of the gas company, for re-installing the ancient lights of Barnet, is more than £100 per annum above the price which they would have charged to electrically light the district if they had been properly approached by the Local Board in February last. It would be interesting to learn from what cause the Board was guilty of a breach of business or professional etiquette which now makes the lighting of Barnet so much more costly to the ratepayers.

Electric Lighting in Belgium. — According to an address delivered by M. Wybauw, there are 544 arc and 9,507 glow lamps in use in Brussels; 240 arcs and 1,481 incandescents in Antwerp; 220 arc and 4,931 glow lamps in Ghent; 384 arcs and 2,040 incandescents in Liège; 665 arc and 2,423 glow lamps in Verviers; 1,500 incandescents in Charleroi; and 1,100 lamps in Ninove.

Litigation and Electric Railway.—*Apropos* to the litigation both commenced and threatened against the electric railway, comes the decision from the Supreme Court of Ohio, U.S.A., on June 2nd. The Court upholds the theory that the street is primarily intended for the use of the general public for the purpose of travelling and transporting goods, and the fact of motive power, which facilitates the object, being changed to something that might interfere with the subordinate use of the highway, ought not to make any difference in that regard.

Tramway Men in Council.—The Tramways Institute of Great Britain and Ireland, which is a young institution, but none the less useful and vigorous, will hold its annual meeting on Thursday next, July 2nd, at 11 a.m., at the Westminster Palace Hotel. After the formal business of electing officers of the society, several papers on "New Methods of Traction" are to be read and discussed, viz.:—(*a*) "Lineff's System of Electric Traction," by Gisbert Kapp; (*b*) "Other Systems of Electric Traction"; (*c*) "Compressed Air Motor," by John Sturgeon (Hughes and Lancaster system); (*d*) "Connolly Motor," by Albert Netter. There will also be an exhibition of tramway appliances. We are glad to note the introduction into the agenda of papers relating to electric traction, and we feel confident that this important question will receive its full share of attention among tramway men. This is just the kind of assembly where electric haulage should be discussed, and where the seed is likely to fall upon fruitful ground if carefully handled. Electrical engineers have for some time successfully invaded the precincts of the American Street Railway Association with results now so well known, and we doubt not that our own pioneers will also impress the members of the kindred British institute with the ever-increasing importance of electric traction. It is only by a judicious combination, and by a thorough mutual understanding between tramway men and electrical engineers that the numerous barriers against the introduction of the various electrical systems can be successfully removed. The British public will be bound to appreciate the advance here, as it has been fully appreciated in nearly all other civilised countries.

CITY NOTES.

The House-to-House Electric Light Supply Company, Limited.

As announced in our last issue, the third ordinary general meeting of this company was held at their central station, Richmond Road, Kensington, on Friday last.

The CHAIRMAN, in presenting the report (published in our last issue) for adoption, said that whilst dealing with the accounts relating to the year 1890, this report also referred to the progress of the company up to the date of its issue, which was approximately 12 months later than the report which dealt with the accounts up to the period ending December 31st, 1889. The company had made steady progress during the period under review, although that progress had not been quite so rapid as might have been predicted from that previously enjoyed. This was partly due to the system of mains having been less extended during the 12 months in question. The result, although in strict accordance with the chairman's anticipations, which he ventured to make on the last occasion he addressed the shareholders, had been somewhat prejudiced by the increased price of coal, which had advanced about 20 per cent. He further stated that it would be noticed from the chart on exhibition that the growth of the company from the commencement had been steadily continuous, but the revenue account of the company for the year 1890 related to an average demand, and it would be seen from the present report that the number of lamps then connected was 16,000 as against 7,000 twelve months ago, and they could therefore assume with all fairness that the returns for the year 1891 will be based upon an average demand for the twelve months from a number of lamps equivalent to that at present connected with the station. They had been able during the past twelve months to effect considerable gains in the working. The City office had been entirely closed. They had dispensed with the draughtsmen and canvassers at Kensington, and they had reduced their establishment expenses. The installation business had been handed over to a fittings company on advantageous terms. These items of economy should result in a reduction in expenditure to the extent of probably £1,000 per year, but the full benefit of that economy was not felt in the balance sheet which had just been put before the shareholders. The chairman stated that they could see their way to further economies in regard to water supply and a few appliances, but that could only result from a capital expenditure which they had not felt justified, up to the present, in incurring, but which they hoped shortly to be able to do. This being the case, the chairman thought that the anticipation which he ventured upon last year—that we now be in the enjoyment of a demand which would ensure them a fair dividend upon their capital—would be substantiated by the results, and he looked forward with confidence to a prosperous future of the undertaking. He regretted that he was not in a position to advise any definite progress with regard to the disposal of their construction asset, but the matter had continually received the attention of the directors, and they believed that negotiations then in progress were granted to be those whereby satisfactory results would be attended. With these observations he moved that the report and accounts for the year ending December 31st, 1890, be received and adopted.

Mr. HAMMOND then seconded the report, and at the same time replied very satisfactorily to remarks made by a shareholder who was present. He then proceeded to show the special advantages they had over other companies of the same nature. In the first place the whole building construction was executed at cost price, which meant a difference of some thousands of pounds to them; the work had been so thoroughly well carried out that they might practically be called "show works," as they had been visited by representatives of newly formed electrical companies from different parts of the United Kingdom. As a proof of this he stated that there was actually to his personal knowledge a station being erected on the same principles as their own, and the directors had given special instructions that in every particular the work should be carried out precisely the same as it was on their station. This certainly gives them a very good reputation. He also stated that they held Parliamentary powers for the district for 42 years. He considered the profits very satisfactory. He also added that he wished the shareholders and others to understand that, pending the building up of the company's business, the directors were not drawing any remuneration. Not only were there no fees charged in the report, but they were not carried to a suspense account—they were absolutely foregone. The report was therefore adopted.

It was then proposed and carried that Messrs. Theobold Bros. and Miall be re-elected as auditors for the present year at a reduced remuneration of 20 guineas.

The West African Telegraph Company, Limited.

THE following report of the directors will be submitted at the sixth ordinary general meeting to be held at Winchester House on Thursday, July 2nd, 1891, at 12.30 p.m.

The company's revenue for that period amounted to £68,377 19s., against which £21,685 13s. 7d. is charged for ordinary expenses, £4,788 14s. 3d. for expenditure relating to repairs for cables, &c., and £639 8s. 5d. for income tax, leaving a balance of £41,264 2s. 9d. From this amount is deducted £23,693 13s. 4d. (being for interest on debentures £14,027, and for sinking fund £9,666 13s. 4d.), leaving a balance of £17,570 9s. 5d., out of which the directors have placed £6,015 19s. 5d. to the general reserve fund.

The shareholders have received for the six months ending 30th June, 1890, an interim payment amounting to 4s. per share, and the directors now recommend a dividend of 6s. per share, making 5 per cent., free of income tax, for the year ended 31st December, 1890; which, with the appropriation to the general reserve fund of £6,015 19s. 5d., will absorb the balance standing to the credit of the revenue account.

The repairs on the Bolama-Bissao cable have caused an expenditure of £2,092 9s. 1d. The work was well and promptly done. In view of future repairs of this character, it has been deemed expedient to join with the affiliated companies in obtaining the services of a maintenance ship, which will be available at all times for similar work. This involves a cost of £2,500 per annum.

The several sections of the company's system of cables are now in good working order.

The traffic, under the arrangements made with the other companies which form a cable communication around the continent of Africa, continues to give good results to this company.

The directors who retire by rotation are Sir Henry C. Mance and John Denison Pender, Esq., who, being eligible, offer themselves for re-election.

The auditors, Messrs. Deloitte, Dever, Griffiths & Co., also offer themselves for re-election.

The West Coast of America Telegraph Company, Limited.—The coupons due on the 30th June on the debentures of the above company, will be paid by Messrs. Barclay & Company, Lombard Street. Coupons must be left three clear days for examination.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ended June 19th amounted to £5,628.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending June 19th, 1891, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brasilian Company were £3,984.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (June 18).	Closing Quotation. (June 25.)	Business done during week ending June 25, 1891. Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 —102	99 —102	...	...
1,381,380*l*	Anglo-American Telegraph, Limited	Stock	46 — 47	45½— 46½	47	...
2,809,310*l*	Do. do. 6 p. c. Preferred	Stock	84 — 85	84½— 85½	85	84¼
2,809,310*l*	Do. do. Deferred	Stock	11 — 11½	11 — 11½	...	...
130,000	Brazilian Submarine Telegraph, Limited	10	11½— 12¼	11½— 12¼	12¼	11⅞
84,500*l*	Do. do. 5 p. c. Bonds	100	101 —104	101 —104	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	104 —108	104 —108	...	...
63,416	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2½— 2⅝	2⅝— 2⅝	2 9/16	2 7/16
63,416	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	1⅝— 1⅞	1⅝— 1⅞	1 13/16	1 11/16
50,000	City and South London Railway, Nos. 1 to 50,000	10	4 — 5	4 — 5	...	...
$7,216,000	Commercial Cable, Capital Stock	$100	106 —108	106 —108	106	105½
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	7/16— 9/16	7/16— 9/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	Stock	4 — 5	4 — 5	...	...
16,000	Cuba Telegraph, Limited	10	10½— 11½	10½— 11½	11	...
6,000	Do. do. 10 p. c. Preference	10	16½— 17½	16½— 17½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¾— 4¼	3¾— 4¼	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	10⅜— 10⅝	10⅜— 10⅝	10⅝	10½
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14½— 14⅝	14⅝— 14⅞	14⅝	14⅝
70,000	Do. 6 p. c. Preference	10	15 — 15½	15 — 15½	15½	15⅛
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 — 110	108⅝	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	106 —109	106 —109	107½	105⅜
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14⅜— 15½	14⅜—15½	15⅛	15⅛
91,800*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	103 —106	103 —106	...	...
325,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	103 —106	103 —106	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	105 —108	105 —108	...	...
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	103 —106	103 —106	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	104 —107	104 —107	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —101	99 —101	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	3 — 4	3½— 4½	3¾	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½— 5	4½— 5	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1¾— 2¼	1¾— 2¼	2¼	2
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3 — 3½	3 — 3½	3 5/16	3
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1½— 1⅝	1½— 1⅝	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9½— 9⅝	9⅝— 9 7/16	9⅝	9½
180,042	Do. do. 6 p. c. Preference	10	15 — 15¼	15 3/16— 15⅜	15 5/16	14⅞
150,000	Great Northern Tel. Company of Copenhagen	10	18½— 19	18½— 19	18½	...
230,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	...	...
9,334*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	10 — 11	10 — 11	...	...
5,334*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11 — 12	11 — 12	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ...	10	18½— 19½	18½— 19½	19½	19¼
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	103 —105	103 —105	...	...
17,000	Indo-European Telegraph, Limited	25	39 — 41	39 — 41	...	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	7½— 8½	7½— 8½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	9¼— 9⅝	9¼— 9⅝	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6½— 7½	6½— 7½	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	106 —109	106 —109	...	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	8⅝— 9¼	9⅝— 10¼	9 13/16	9⅜
438,984	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 5	4 7/16— 5 1/16	5 1/16	4⅞
15,000	Do. 6 p. c. Cum., 1st Preference	10	12¼— 12⅜	12¼— 12⅜	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	12 — 12½	12 — 12½	12	...
350,000	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	104 —106	104 —106	105⅜	105
6,318*l*	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	4½— 5½	4½— 5	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	¼— ⅜	¼— ⅜	...	...
9,000	Reuter's Limited	8	8 — 8½	8 — 8½	...	...
3,381	Submarine Cables Trust	Cert.	114 —118	114 —118	116½	116¼
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	4½— 5	4½— 5	...	...
37,350	Telegraph Construction and Maintenance, Limited	12	46 — 48	46 — 48	46½	46
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	103 —106	103 —106	...	...
58,000	United River Plate Telephone, Limited	5	2½— 3½	2½— 3½	...	...
146,128*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
3,200*l*	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8 — 9	8 — 9	...	...
290,900*l*	Do. do. do. 5 p. c. Debentures	100	95 — 98	95 — 98	...	...
30,000	West Coast of America Telegraph, Limited	10	3½— 4½	3½— 4½	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	100 — 105	100 — 105	...	...
64,174	Western and Brazilian Telegraph, Limited	15	11 — 11½	11¼— 11⅜	11 11/16	11
27,873	Do. do. do. 5 p. c. Cum. Preferred	7½	6½— 7	6½— 7	...	...
27,873	Do. do. do. 5 p. c. Deferred	7½	4½— 5	4½— 5	4⅝	...
200,000*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 —106	103 —106	104	...
250,000*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	104	...
88,321	West India and Panama Telegraph, Limited	10	2⅜— 3	2⅜— 2⅞	2 15/16	2 13/16
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10⅜— 11½	10 — 10½	10½	...
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	9½— 10½	9½— 10½	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	117 —122	117 —122	...	...
175,100*l*	Do. do. 6 p. c. Sterling Bonds	100	100 —104	100 —104	...	..
42,853	*Westminster Electric Supply Corporation, Ord., Nos. 101 to 42,953	5	4⅜— 5½	4⅜—5½	...	...

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½—7⅞.—City of London Electric Lighting (Pioneer), Shares of £50, £25 paid, 36—37.—Elmore's Austrian Copper Depositing, 15s., 25s.—Elmore's Priorities, 3¾—4½.—House to House Company (£5 paid) 4½—5.—Liverpool Electric Supply, £3 paid, 2—2½.—London Electric Supply Corporation, Ordinary (£5 paid), 2—2½.—Manchester, Edison and Swan Company, £9 (£1 paid) 2s 6d.—5s.—National Telephone Debentures, 2½—3 prem.—St. James's and Pall Mall Electric Light £5, 5⅞—6⅛.—St. James's and Pall Mall, 7 per cent. pref., ⅜—1 prem.—Woodhouse and Rawson Ordinary of £5 (£2 10s. paid), 2—2½.—£5 Preference, fully paid 3⅞—4⅛.—Debentures 90—95.—Wards Electric Car, £10 paid, ⅜—1.

BANK RATE OF DISCOUNT.—3 per cent. (18th June, 1891).

PROCEEDINGS OF SOCIETIES.

Royal Society.

ON ELECTRICAL EVAPORATION. By WILLIAM CROOKES, F.R.S.

(*Concluded from page 798.*)

Volatilisation of Silver.—Silver was the next metal experimented upon. The apparatus was similar to that used for the cadmium experiments (fig. 7). Small lumps of pure silver were cast on the ends of platinum wires, and suspended to the inner ends of platinum terminals passing through the glass bulb. The platinum wires were protected by glass, so that only the silver balls were exposed. The whole apparatus was enclosed in a metal box lined with mica, and

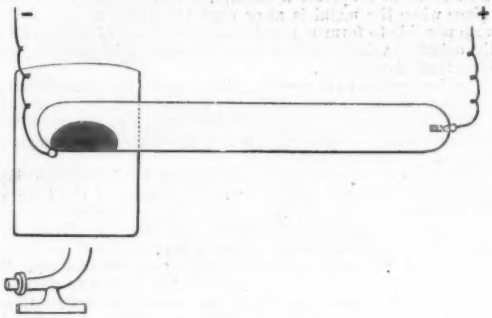


FIG. 8.

the temperature was kept as high as the glass would allow without softening. The apparatus was exhausted to a dark space of 3 mm., and the current was kept on for 1½ hours. The weights of silver, before and after the experiment, were as follows:—

	Positive pole.	Negative pole.
Original weight of silver	18·14 grs.	24·63 grs.
Weight after the experiment ...	18·13 „	24·44 „
Silver volatilised in 1½ hours ...	0·01 „	0·19 „

It having been found that silver volatilised readily from the negative pole in a good vacuum, experiments were instituted to ascertain whether the molecules of metal shot off from the pole were instrumental in producing phosphorescence. A glass apparatus was made as shown in fig. 9. A pear-shaped bulb of German glass has, near the small end, an inner concave negative pole, A, of pure

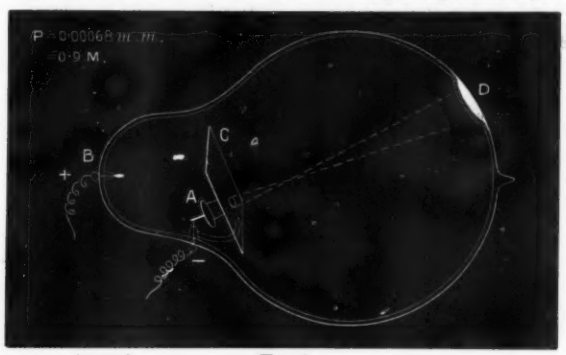


FIG. 9.

silver, so mounted that its inverted image is thrown upon the opposite end of the tube. In front of the pole is a screen of mica, having a small hole in the centre, so that only a narrow pencil of rays from the silver pole can pass through, forming a bright spot of phosphorescence, D, at the far end of the bulb. The exhaustion was pushed to a high point, 0·00068 mm., or 0·9 M. The current from an induction coil was allowed to pass continuously for some hours, the silver pole being kept negative, so as to drive off a certain portion of the silver electrode. On subsequent examination it was found that the silver had all been deposited in the immediate neighbourhood of the pole, whilst at the far end of the tube the spot D, that had been continuously glowing with phosphorescent light, was practically free from silver.

A tube was next made as shown in fig. 10. It had two negative poles connected together, A, A', so placed as to project two luminous spots on the phosphorescent glass of the tube. One of the electrodes, A', was of silver, a volatile metal; the other, A, was of aluminium, practically non-volatile. On connecting the two negative poles, A, A', with one terminal of the coil, and the positive pole, B, with the other terminal, it was seen in the course of half an hour that a considerable quantity of metal had been projected from the silver negative pole, blackening the tube in its neighbourhood, while no projection of metallic particles took place from the aluminium positive pole. During the whole time of the experiment, however, the two patches of phosphorescent light, C and C', had been glowing with exactly the same intensity, showing that the active agent in effecting phosphorescence was not the molecules of the solid projected from the poles, but the residual gaseous particles, or "radiant matter."

In the tubes hitherto made containing silver, it had not been easy to observe the spectrum of the negative pole, owing to the rapid manner in which the deposit obscured the glass. A special tube (fig. 11) was therefore devised, of the following character. The silver pole, A, was attached to the platinum pole at one end of the tube, and the aluminium positive pole, B, was at the side. The end of the tube opposite the silver pole was rounded, and the spectroscope was arranged to observe the light of the volatilising silver "end on," as

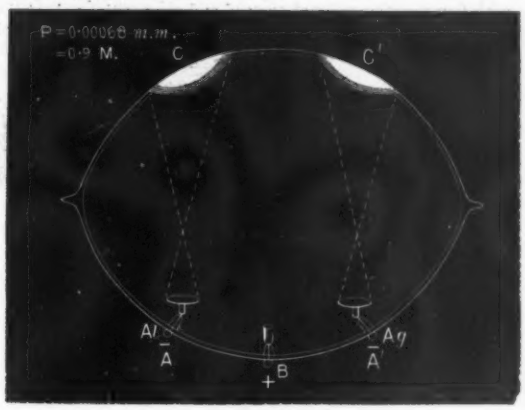


FIG. 10.

shown in the figure. In this way the deposit of silver offered no obstruction to the light, as none was deposited except on the sides of the tube surrounding the silver. At a vacuum giving a dark space of about 3 mm. from the silver, a greenish-white glow was seen to surround the metal. This glow gave a very brilliant spectrum. The spark from silver poles in air was brought into the same field of view as the vacuum glow, by means of a right-angled prism attached to

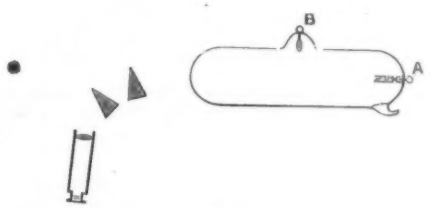


FIG. 11.

the spectroscope, and the two spectra were compared. The two strong green lines of silver were visible in each spectrum; the measurements taken of their wave-lengths were 3,344 and 3,675, numbers which are so close to Thalén's numbers as to leave no doubt that they are the silver lines. At a pressure giving a dark space of 2 mm. the spectrum was very bright, and consisted chiefly of the two green lines and the red and green hydrogen lines. The intercalation of a Leyden jar into the circuit does not materially increase the brilliancy of the lines, but it brings out the well-known air lines. At this pressure not much silver flies off from the pole. At a higher vacuum, the luminosity round the silver pole gets less and the green lines vanish. At an exhaustion of about one-millionth of an atmosphere the luminosity is feeble, the silver pole has exactly the appearance of being red hot, and the volatilisation of the metal proceeds rapidly.*

If, for the negative electrode, instead of a pure metal such as cadmium or silver, an alloy was used, the different components might be shot off to different distances, and in this way make an electrical separation—a sort of fractional distillation. A negative terminal was formed of clean brass, and submitted to the electrical discharge *in vacuo*; the deposit obtained was of the colour of brass throughout, and on treating the deposit chemically I could detect no separation of its component metals, copper and zinc.

Returning to the analogy of liquid evaporation, if we take several liquids of different boiling points, put them under the same pressure,

* Like the action producing volatilisation, the "red heat" is confined to the superficial layers of molecules only. The metal instantly assumes, or loses, the appearance of red heat the moment the current is turned on or off, showing that, if the appearance is really due to a rise of temperature, it does not penetrate much below the surface. The extra activity of the metallic molecules necessary to volatilise them is, in these experiments, confined to the surface only, or the whole mass would evaporate at once, as when a metallic wire is deflagrated by the discharge of a powerful Leyden jar. When this extra activity is produced by artificial heat one of the effects is the emission of red light; so it is not unreasonable to imagine that when the extra activity is produced by electricity, the emission of red light should also accompany the separation of molecules from the mass. In comparison with electricity, heat is a wasteful agent for promoting volatilisation, as the whole mass must be raised to the requisite temperature to produce a surface action merely; whereas the action of electrification does not appear to penetrate much below the surface.

and apply the same amount of heat to each, the quantity passing from the liquid to the gaseous state will differ widely in each case.

It was interesting to try a parallel experiment with metals, to find their comparative volatility under the same conditions of temperature, pressure, and electrical influence. It was necessary to fix upon one metal as a standard of comparison, and for this purpose I selected gold, its electrical volatility being great, and it being easy to prepare in a pure state.

An apparatus was made as in fig. 12. It is practically a vacuum tube with four negative poles at one end and one positive pole at the other. By a revolving commutator I was able to make electrical

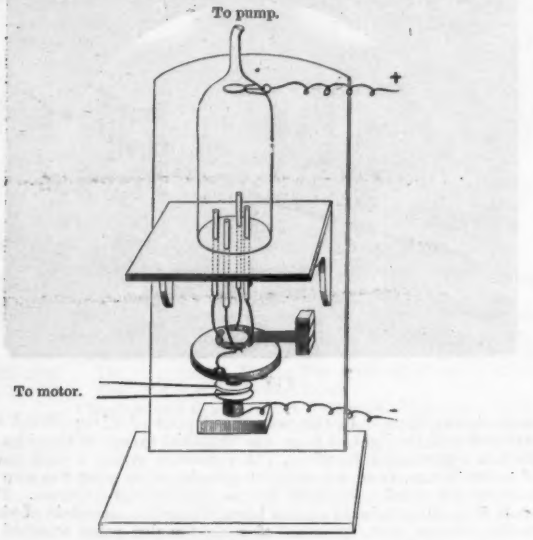


FIG. 12

connection with each of the four negative poles in succession for exactly the same length of time (about six seconds); by this means the variations in the strength of the current, the experiment lasting some hours, affected each metal alike.

The exposed surface of the various metals used as negative poles was kept uniform by taking them in the form of wires that had all been drawn through the same standard hole in the drawplate, and cutting them by gauge to a uniform length; the actual size used was 0·8 mm. in diameter, and 20 mm. long.

The comparison metal gold had to be used in each experiment; the apparatus thus enabled me to compare three different metals each time. The length of time that the current was kept on the revolving commutator in each experiment was eight hours, making two hours of electrification for each of the four negative electrodes; the pressure was such as to give a dark space of 6 mm.

The fusible metals, tin, cadmium, and lead, when put into the apparatus in the form of wires, very quickly melted. To avoid this difficulty a special form of pole was devised. Some small circular porcelain basins were made, 9 mm. diameter; through a small hole in the bottom a short length of iron wire, 0·8 mm. in diameter, was passed, projecting downwards about 5 mm.; the basin was then filled to the brim with the metal to be tested, and was fitted into the apparatus exactly in the same way as the wires: the internal diameter of the basins at the brim was 7 mm., and the negative metal filed flat was thus formed of a circular disc 7 mm. diameter. The standard gold pole being treated in the same way, the numbers obtained for the fusible metals can be compared with gold, and take their place in the table.

The following table of the comparative volatilities was in this way obtained, taking gold as = 100:—

Palladium	108·00
Gold	100·00
Silver	82·68
Lead	75·04
Tin	56·96
Brass	51·58
Platinum	44·00
Copper	40·24
Cadmium	31·92
Nickel	10·99
Iridium	10·49
Iron	5·50

In this experiment equal surfaces of each metal were exposed to the current. By dividing the numbers so obtained by the specific gravity of the metal, the following order is found:—

Palladium	9·00
Silver	7·88
Tin	7·76
Lead	6·61
Gold	5·18
Cadmium	3·72
Copper	2·52
Platinum	2·02
Nickel	1·29
Iron	0·71
Iridium	0·47

Aluminium and magnesium appear to be practically non-volatile under these circumstances.

The order of metals in the table shows at once that the electrical volatility in the solid state does not correspond with the order of melting points, of atomic weights, or of any other well-known constant. The experiment with some of the typical metals was repeated, and the numbers obtained did not vary materially from those given above, showing that the order is not likely to be far wrong.

It is seen in the above table that the electrical volatility of silver is high, while that of cadmium is low. In the two earlier experiments, where cadmium and silver were taken, the cadmium negative electrode in 30 minutes lost 7·52 grs., whilst the silver negative electrode in 1½ hours only lost 0·19 gr. This apparent discrepancy is easily explained by the fact (already noted in the case of cadmium) that the maximum evaporation effect, due to electrical disturbance, takes place when the metal is at or near the point of liquefaction. If it were possible to form a negative pole *in vacuo* of molten silver, then the quantity volatilised in a given time would be probably much more than that of cadmium.

Gold having proved to be readily volatile under the electric current, an experiment was tried with a view to producing a larger quantity of the volatilised metal. A tube was made having at one end a negative pole composed of a weighed brush of fine wires of pure gold, and an aluminium pole at the other end.

The tube was exhausted and the current from the induction coil put on, making the gold brush negative; the resistance of the tube was found to increase considerably as the walls became coated with metal, so much so that, to enable the current to pass through, air had to be let in after a while, depressing the gauge ½ mm.

The weight of the brush before experiment was 35·4940 grs. The induction current was kept on the tube for 14½ hours; at the end of this time the tube was opened and the brush removed. It now weighed 32·5613, showing a loss of 2·9327 grs. When heated below redness the deposited film of gold was easily removed from the walls of the tube in the form of very brilliant foil.

After having been subjected to electrical volatilisation, the appearance of the residual piece of gold under the microscope, using a ¼ inch object glass, was very like that of electrolytically deposited metal, pitted all over with minute hollows.

This experiment on the volatilisation of gold having produced good coherent films of that metal, a similar experiment was tried, using a brush of platinum as a negative electrode. On referring to the table it will be seen that the electrical volatility of platinum is much lower than that of gold, but it was thought that by taking longer time a sufficient quantity might be volatilised to enable it to be removed from the tube.

The vacuum tube was exhausted to such a point as to give a dark space of 6 mm., and it was found, as in the case of gold, that as a coating of metal was deposited upon the glass the resistance rapidly increased, but in a much more marked degree, the residual gas in the tube apparently becoming absorbed as the deposition proceeded. It was necessary to let a little air into the tube about every 30 minutes, to reduce the vacuum. This appears to show that the platinum was being deposited in a porous spongy form, with great power of occluding the residual gas.

Heating the tube when it had become in this way non-conducting liberated sufficient gas to depress the gauge of the pump 1 mm., and to reduce the vacuum so as to give a dark space of about 3 mm. This gas was not re-absorbed on cooling, but on passing the current for 10 minutes the tube again refused to conduct, owing to absorption. The tube was again heated, with another liberation of gas, but much less than before, and this time the whole was re-absorbed on cooling.

The current was kept on this tube for 25 hours; it was then opened, but I could not remove the deposited metal except in small pieces, as it was brittle and porous. Weighing the brush that had formed the negative pole gave the following results:—

	Grains.
Weight of platinum before experiment	10·1940
" after "	8·1570
Loss by volatilisation in 25 hours	2·0370

Another experiment was made similar to that with gold and platinum, but using silver as the negative pole, the pure metal being formed into a brush of fine wires. Less gas was occluded during the progress of this experiment than in the case of platinum. The silver behaved the same as gold, the metal deposited freely, and the vacuum was easily kept at a dark space of 6 mm. by the very occasional admission of a trace of air. In 20 hours nearly 3 grs. of silver were volatilised. The deposit of silver was detached without difficulty from the glass in the form of brilliant foil.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1890.

180. "Improvements in automatic telegraphs." E. EDWARDS. (A communication from abroad by E. Cassalette and D. Kunhardt, both of Germany.) Dated January 4th. 1s. 1d. Relates to improvements in automatic telegraphs of the kind for which the inventors applied for letters patent in the United Kingdom the 22nd day of October, 1888, and numbered 15,183. 1 claim.

1,939. "An automatic electric temperature alarm." M. H. L. BOUGAULT. Dated February 5th. 8d. Consists of a box carrying a metallic thermometer operating a rotary indicator. The face of the box is formed as a dial, and provided with a scale of degrees of tem-

perature around its circumference. A cross bar is pivoted centrally on this dial, and is provided at end with an indicating point, so that it may be accurately adjusted to point to any desired degree on the scale. This end of the cross bar carries a pivoted metallic plate, covered on one side with ivory or other material non-conductive of electricity, the plate being reversible. Suitable connections are made with the poles of the generator, so that an alarm is given when the rotary indicator touches the pivoted plate on its conductive side, which will happen when the temperature rises or falls respectively to the degree at which the cross bar is set. 2 claims.

2,219. "Improvements in telegraph-printing apparatus." H. O. RUDOLPH. Dated February 11th. 11d. Relates to telegraph printing apparatus adapted to print on a travelling paper, tape or strip. 5 claims.

2,273. "Improvements in voltaic cells or primary batteries." G. R. POSTLETHWAITE. Dated February 12th. 11d. Consists in dispensing with the well-known porous pot and its resistance, and with the outer stoneware, glass, or porcelain jar, with their attendant weight and bulk, and also that of corroded joints and connections. 10 claims.

2,297. "Improvements in apparatus to be used for electrolytic purposes." J. C. RICHARDSON and T. J. HOLLAND. Dated February 12th. 8d. Claim:—Apparatus to be used in electrical decomposition of salt and other solutions, consisting of a tank divided by a partition or partitions of non-porous character, extending through part of the section of the solution under treatment, and serving to maintain the separation of the elements produced, and thereby preventing their recombination, in the manner described.

2,298. "Improvements in and connected with electric calls and indicators for hotels." S. GARDINER. Dated February 12th. 8d. Comprises certain new or improved arrangements of devices and apparatus to be applied to the bedrooms of hotels, whereby the occupant before retiring may give notice on the outside of the door when he requires to be called in the morning, and so that the boots or porter, in coming round late at night or early in the morning to remove the boots for cleaning, will see the hour the occupant desires to be called in the morning and either attend to this himself or give orders to ensure that it is done by the proper attendant, who when he comes to the particular bedroom in the morning will by a further arrangement of improvements touch an electric switch at the door, which will ring an electric bell on the mantelpiece or at the head of the bed, which will continue to ring until the occupant turns it off himself by moving a switch attached thereto. 4 claims.

4,242. "An improvement in electric railway signals." A. SIEMENS. Dated March 18th. 8d. Relates to automatic railway signal apparatus worked by electric currents, as described in specification No. 15,921 of 1888, and consists in the combination in such a manner that two or more signals require to be brought into "danger" position before another signal can be brought into the "line clear" position. 1 claim.

4,384. "Improvements in plates for secondary batteries or accumulators." J. PITKIN and H. C. L. HOLDEN. Dated March 20th. 6d. The inventors carry the active material in trays or shelves of metallic lead or similar substance, arranged one over the other, with some slight space between them, and connected at the ends to upright strips of conducting material, which, if metallic lead, may be readily cast so as to secure the trays. 2 claims.

4,699. "Improvements in telephony." M. G. KELLOGG. Dated March 25th. 11d. The inventor divides the lines of the exchange into a number of divisions, and he divides the switchboards of the exchange into the same number of divisions. Each division of lines has its own division of boards, but the lines are connected also to boards of the other divisions, as will hereafter be described. The number of divisions and the number of boards in each division will depend on the size and activity of the exchange. On each board of each division is a switch or switch connection for each line of the division to which the boards belong. Each line has also a switch or switching connection on one board in each of the other divisions. 18 claims.

20,019. "Improvements in circuits for electric railways." F. W. SABOLD. Dated December 9th. 6d. Consists in combining with an overhead electric conductor the track rails of a railway which are electrically connected with a series of metallic bars inserted in the ground adjacently to, and in line with, the railway tracks; said bars being spaced apart at a distance which will correspond to the length of an ordinary track rail, or nearly so, so that a car equipped with the usual motor and conducting wires will, in its transit over said tracks, effect a constant variation in the length of the electric circuit, making the latter longer or shorter according to the direction in which the car is moving in respect to the generator; the course pursued by the electric current from the dynamo or generator being through the overhead conductor or trolley wire downward through the conducting wires of the car to the track rails, thence to the metallic bars through the wires connecting said bars with the track rails, then from said bars through the earth back to the generator, the earth alone being used to complete the circuit from the metallic bar nearest the point on the track where the car is at that time located to the dynamo or generator, regardless of the fact whether at the time the car is in motion or remaining stationary. 1 claim.

ELECTRICITY IN THE ART OF TANNING.

THE slow rate at which a hide is converted into leather in the ordinary process of tanning has induced many inventors to devise methods by which the chemical change might be accelerated without deterioration of the quality of the leather produced; but the want of definite knowledge as to the precise nature of the interaction which takes place between the gelatine of the raw hide and the various tannings employed in this industry has been a serious obstacle in the development of these methods, and many of the proposals, after being tried on a small scale, have been abandoned in favour of the old and slow process.

Some of the "quick" processes have depended upon purely chemical reactions. More frequently, however, they have been based upon mechanical considerations; such are, for instance, the processes of Spilsbury, Knowles and Brown.

The mechanical processes are designed for an obvious purpose; but when we come to the application of electricity to tanning—one of the most promising of the quick methods—we find that the inventors are at first groping in the dark, using a powerful agent, but with no rational principle or motive. The only *à priori* reasons for applying an electric current to a hide in a tan pit are, that some electrolytic action *may* liberate some tanning agent in a nascent state, that dialysis is accelerated by the passage of a current, and that there is a relation between osmosis and electrolysis.

As early as 1849 a tanner, named Crosse, proposed to utilise "electricity or galvanism for tanning purposes." The electrodes consisted of sheets of zinc and lead, immersed in an ordinary tan pit in which water and the hides were placed, bark or other tanning material being added from time to time after the skins had been subjected to this action for some days.

Ward, in Lancashire, some years later, passed a current of electricity through the tanning liquor in ordinary tan pits.

In 1861 Rebu made several experiments on electrical tannage, employing various metallic salts as well as ordinary liquors in his pits.

In 1874 De Mertens, of St. Petersburg, turned his attention to the subject, and has for some years adopted, in nearly 600 pits, the following plan of electric tanning. A layer of carbon, connected with the positive pole of a dynamo, is placed at the bottom of each vat, and it is then filled with alternate layers of moist skins and tan, a plate of zinc forming the negative pole at the top of the pit.

In 1876, Lucien Gaulard and Kresser proposed another process, in which they used two parallel plates of carbon, and immersed the hides between them in tanning liquor, passing a continuous current of electricity through from plate to plate. Leather made by this process was exhibited in London in 1883.

The process of Landin and Abom has been worked for more than two years in the tan-yard of Messrs. Nielson and Norrköping, in Sweden. Here the hides are attached to wooden frames, and are placed in a pit. Large copper electrodes are provided, and an alternating current is passed.

A simple combination of motion and electrical treatment was patented in France by Worms and Balé in 1887, and consists of a large drum, some 11 feet in diameter, mounted on a horizontal shaft, filled one-third full of tanning liquor, together with some turpentine, and in this half-a-ton of hides are placed loose. The drum is set in motion by steam power, and a current of about 10 ampères is passed through the contents by means of copper electrodes placed on the interior surface at the ends of the drum.

Nicholson and Palmer (English patent, No. 9,776, 1889) have also described a similar process, in which the hides are suspended on the positive electrode within the rotating drum, and the current of electricity is caused to flow mainly through the hides.

Another system of tanning, which is quite distinct from any of the above, is the Groth system. In Groth's apparatus there is a combination of motion and electrical treatment; but the motion is of such a nature that the hides being left stretched and suspended in the liquor, are not churned about or rubbed one on the other as in Worms and Balé's process.

Groth's invention has been worked in two practical forms in the Grange Works, Bermondsey. In one of them there is a round vat containing a revolving frame carrying the hides, and in the second there is a rectangular tank, in which a similar frame is carried to and fro, running on wheels, and moved by a crank.

This system has recently been the subject of a series of experiments by Messrs. Rideal, D.Sc., &c., and A. P. Trotter, B.A., &c., and at a recent meeting of the Society of

Chemical Industry, London section, these gentlemen gave an exhaustive account of their labours. It is from their paper that we make this abstract.

One of the circular vats placed at the disposal of Messrs. Rideal and Trotter at the Grange Works, Bermondsey, was 7 feet 3 inches in diameter and 6 feet 4 inches deep. The cubical contents were thus about 315 cubic feet, or nearly 2,000 gallons. The sectional area in a vertical plane was about 43½ square feet; the superficial area was 42 square feet.

A strong central shaft turns in bearings, and is driven by bevel gear, the arrangement being precisely like a brewer's mash tun. Wooden arms are attached to the shaft, and carry cross-pieces. These are provided with a number of brass hooks, by means of which the hides are hung vertically about an inch apart, all the metal work in contact with the liquor being brass or copper.

Electrodes are placed against the sides of the vat. These consist of strips of copper, arranged gridiron fashion. Four strips, 4 feet 3 inches long by 2 inches wide, are placed 8 inches apart, and are connected at the top and at the bottom by strips of similar width. The whole surface exposed is therefore about 4 square feet.

Messrs. Rideal and Trotter also carried out some experiments in a rectangular vat, in which the hides were moved backwards and forwards longitudinally.

The tanning liquors were made of the usual materials, and during the tanning were strengthened from time to time in the usual way, and the hides were prepared for tanning by liming, unhairing, fleshing, and colouring, as practised by most tanners.

The current of electricity was varied in different experiments, according to the nature of the hides and the strength of the liquor. This is important in order to obtain satisfactory results.

Previous to this investigation a series of experiments, in which the current varied from 1 to 30 ampères, had been made; the best results were obtained with the weak currents, and the considerable loss due to electrolytic action when a greater current was employed was thereby avoided. With a current from 1½ to 4 ampères the density is from 0·375 to 1 ampère per square foot of electrode, and from 0·0345 ampères per square foot of transverse sectional area of the contents of the vat to 0·092 ampère per square foot.

For currents from 1·3 up to 2·3 ampères, the total resistance of the liquor at 9° C., sp. gr. 101, expressed for convenience in ohms, was 87. On another occasion at 7° C., sp. gr. 1·019, the resistance was 7·7 ohms with 2·3 ampères. In each case the resistance was measured by observing the current and the volts between the electrodes. The quotient gives the sum of the ohmic resistance and of the polarisation. Exploration of the vat by means of a movable electrode showed that the flow of current was very uniform.

In the earlier experiments the current and voltage were observed, the vat being full of tanning liquor up to a certain mark. The hides were then put in, displacing a certain quantity of liquor. This was removed until it stood at the same mark as before, and the resistance was again determined.

The results obtained in this way, however, did not give any very definite information as to the variation in the resistance of the hides during their conversion into leather, but were sufficient to show that the hides when just immersed did not offer any material additional resistance to the electric current. Arrhenius (B.A. Electrolysis Report, 1887, 345), has previously pointed out that the resistance of solidified gelatine is not different from that of gelatine solution.

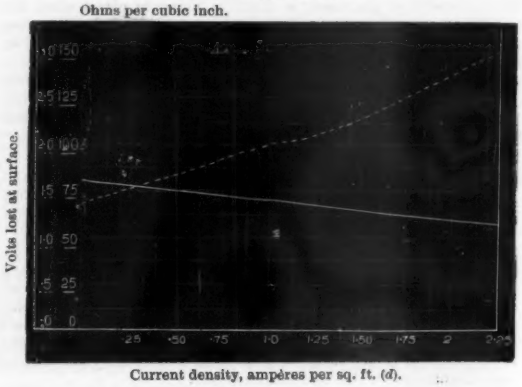
A more careful and accurate series of observations was subsequently made on the electrolytic resistance of the tanning solution, from which curves were obtained.

The temperature coefficient was, as might be expected, negative. The resistance decreased 0·9 ohm for a rise of 1° C., or 1·32 per cent. at 16° C., falling from 75 ohms per cubic inch, at 8·6° C. to 59 ohms per cubic inch at 26° C. The liquor used was a strong solution containing 4·25 per cent. of tanning, obtained from mimosa bark and gambier. The same sample was tested for the purpose of ascertaining the true ohmic resistance, and the fall of volts due to the polarisation with different current densities on the electrodes.

The resistance of the given sample of the liquor at 8·5° C. was 82 ohms per cubic inch—11 d where d is the density in ampères per square foot of electrode. This is shown by the following line in fig.

$$v = 82 - 11\,d.$$

POLARISATION EFFECT.



The voltage lost at the surface of the electrode is not so simple a quantity. It tends to a minimum of 1·4 volts for a minimum current, and the two following empyrical formulæ closely approximate to the observed curve—

$$\text{Volts} = 1{\cdot}4 + 45\,d^{1{\cdot}2}$$

$$\text{or} = 1{\cdot}4 + 0{\cdot}194\,d \times 8d^{2}$$

where d is the density of current in ampères per square foot. This is shown by the rising curve on fig.

(*To be continued.*)

THE ROYAL SOCIETY'S SOIREE.

AMONG the exhibits at the *conversazione* at Burlington House, on the 17th inst., were to be seen the set of Roman tools that were on view and created so much interest and lively discussion at the former *soirée*.

Mr. WIMSHURST showed an electrical motor worked by means of the current obtained from an influence machine. It consists of a glass disc, mounted on a vertical spindle, and carrying on one face a number of tinfoil sectors. The upper face of the disc is touched at two places by brushes connected by wires to the poles of the influence machine, while at right angles to the diameter joining these brushes there are two other brushes, connected together by an equalising rod. Below the rotating disc is a stationary one, having upon it two sectors of tinfoil extending about 90°. These sectors are also in communication with the poles of the influence machine. As soon as the latter is put in motion, the glass disc begins to rotate and rapidly attains a very considerable speed, turning with an amount of force which is quite remarkable. A similar effect is produced, but to a less extent, by presenting the knob of a Leyden jar to one pole of the motor.

Mr. FRANCIS GALTON, F.R.S., had an interesting exhibit to illustrate the use of finger marks for the identification of people, which might be used instead of the ordinary signature, and with more propriety be called putting one's hand to a document. The person who is to make his mark places his fingers on an inked pad and then impresses them on a piece of paper. The result is a print of the papillary ridges on the bulbs on the fingers, and it appears that every individual has a pattern which is as distinctive as his features. There is also reason to believe that these impressions do not alter during the whole period of a person's life. The various types of impressions have been classified, so that the characteristics of each finger mark can be scheduled under an assigned number.

Prof. S. P. THOMPSON exhibited an apparatus showing a curious optical illusion. On two rotating discs, A and B, are spiral patterns in black and white, which seem to move radially inwards and outwards respectively. Let the observer gaze fixedly for about one minute at the centre of A, and then suddenly transfer his gaze to any object—say the face of a friend—he will see that object apparently enlarging from the middle outwards. After similarly gazing for a minute at B, and then looking at any object, he will see it apparently

diminishing. Prof. Thompson says this experiment disproves the theory of M. Javal (Director of the Ophthalmological Laboratory of the Sorbonne), that the complementary subjective illusions of motion are due to involuntarily slipping of the muscles of the eyeball, for they cannot slip radially in all directions at once.

We hardly think the deduction from this experiment is very convincing.

Prof. JOHN PERRY showed an indicator for high speed steam or other engines.

Prof. J. J. THOMSON showed a number of experiments on the discharge of electricity through gases without the aid of electrodes, some of which had been shown at the recent meeting of the Physical Society at Cambridge, while others were new. The discharge tube in all these experiments is made to form the secondary of what is essentially an induction coil, and the discharge passes round a closed circuit in the gas. One of the most interesting of these illustrated the fact recently discovered by Prof. Thomson, that a magnetic field facilitates a discharge of this kind along the lines of force, while at right angles to them the discharge is retarded. When the discharge passes through oxygen, there is a kind of residual glow.

Mr. J. JOLY exhibited an instrument, to which he has given the name of "Meldometer," for determining the melting point of minute quantities of substances, by comparison with those of bodies whose melting points are known. The method consists in measuring the thermal expansion of a ribbon of pure platinum, when a minute quantity of a substance, dusted on its surface, and observed through a microscope, is melting. The platinum ribbon is heated by an electric current, and the thermal value in degrees Centigrade of its expansion determined by preliminary observations with bodies of known melting point. The expansion is read by an electro-contact method. The instrument exhibited has a range up to about 1,600° C., and reads to within 2° C.

Mr. SHELFORD BIDWELL had a nickel pendulum to illustrate the effect of heat upon the magnetic susceptibility of nickel. Nickel, at ordinary temperature magnetic, loses this power at about 300° C. A pendulum having a nickel tongue or armature, is deflected, attracted by a magnet. The heat of a spirit lamp, placed under the tongue, quickly destroys the magnetism of the nickel armature, so that the magnet can no longer hold it, and the pendulum is released. The oscillation of the pendulum is kept up by the periodical attraction of the magnet on the nickel tongue, and the periodical release of the latter when heated.

Mr. PIAZZI SMYTH devoted much space in his work on the Great Pyramid of Egypt to prove that the building was erected for astronomical purposes, and that a certain inclined passage within the structure served as a telescope, through which to observe the transit of the then pole star (α Draconis). Mr. NORMAN LOCKYER has been carrying on some further investigations in the same direction on other buildings, and he exhibited photographs of the great temples of Karnak and Edfou, which show a long covered way, extending 600 yards in an east and west direction. On Midsummer Day, just passed, observations were to be made to see whether the axis of the Temple of Karnak is directed exactly on to the point of sun setting and rising, and, if not, by how far it departs from it. If it were originally laid out on that line it would now be displaced owing to the precession of the equinoxes, and it would be possible to compute at what date it was in the exact position. It is believed that the temple has been built 6,000 years, and it will be very interesting if this date can be confirmed. It is also evident that the long covered way acted as a telescope tube, and would enable the priests to calculate very exactly the length of the year. Similar researches are being carried out at Stonehenge.

Mr. LUDWIG MOND exhibited samples of nickel-carbon-oxide, which was obtained in 1890 by Mond, Langer, and Quincke, by passing a current of carbonic oxide over finely-divided metallic nickel at the ordinary temperature, and refrigerating the resulting gas. The result is a colourless liquid, of high refracting power, boiling at 43° C., and solidifying at 25° C.; it is split up again into nickel and carbonic oxide on heating its vapour to 180° C. The properties of this substance make it possible to volatilise nickel at a low temperature, and to extract it industrially in a perfectly pure state from all other substances with which it is found. By exposing heated metallic articles to the vapour of nickel-carbon oxide, they are immediately coated with nickel.

Captain ABNEY and General FESTING showed an apparatus for the registration of colours. The registration consists in referring any mixed colour to a single wave length and a percentage of white light, and another apparatus to show the greater sensitiveness to the eye of different colours, a comparison is made by placing two colours side by side, which are at ordinary intensity of equal luminosity, and by their diminishing the intensity of each equally. For example, a red which at normal light was more brilliant than blue-green was utterly dark long before the green disappeared under diminishing light.

There were many other exhibits worthy of notice for which we cannot find space, and regretfully have to omit.

A STUDY OF AN OPEN COIL ARC DYNAMO.*

PROFESSOR ELIHU THOMSON: I called Mr. Thompson's attention in regard to the blowing out of the spark as expressing an erroneous idea in relation to the machine. This he would find expressed in Silvanus Thompson's "Dynamo Electric Machinery," and that the air space in the Thomson-Houston three coil machine is for the purpose of blowing out the spark. That is not at all the case and never was, and the air blast was introduced for no other purpose than to make it possible to run the machine steadily at high differences of potential with a commutator which could be freely oiled. It was found in the early experience with the machine that it was possible to construct a machine up to about 12 to 15 arc lamps which would retain the normal working condition without flashing over, as it is called—short circuiting across the slots and the short circuit being carried around. But beyond that potential difference there was an imminent danger of its occurring, although a 25-light machine might run for an hour or an hour and a half without any flashing or short circuiting over. Of course, the tendency to flash over increased with the difference in potential. Now, it was also desirable to run the commutator with a film of oil to freely oil the machine, and when the commutator was freely oiled, the limiting potential which could exist without flashing was much lower. Even a ten-light machine might flash readily if there was a good deal of oil on the commutator. In the early days men would oil the commutator. It was almost impossible to keep them from taking an oil can and squirting on the commutator. The Brush machines were very sensitive also to this same action, and their recommendations were very distinct as to what was to be done to oil the commutator—that is, to take a rag and grease it with a little vaseline and touch the commutator lightly. If the commutator was thoroughly oiled there would at once be a flash. Another thing, the oil on the commutator, of course, diminished the wear, so that if there was any little roughening it was relieved a great deal from cutting and making copper dust around the commutator. I tried in the early days to get rid of the difficulty and did get rid of it by using condensers on the machine. I took the three coils. I led our connections from each segment to a triple condenser. That preceded the development of the air blast. There were three coils in inductive relation. On a machine up to six or eight lights, I found I could actually obliterate the sparking at the tips of the brushes, and the brushes could be moved quite a distance without causing sparks while the machine was carrying its load. But I also found that the condenser was very subject to perforation. There were conditions arising which raised the potential enormously, and I could under certain conditions get static charges, and this is a very interesting matter indeed, as looked at from the present standpoint in relation to alternating charges. From a single turn of the wire leading from the segment to the condenser coil, I could get discharges of an eighth of an inch from one to the other, a discharge which refused to run around the coil, in fact, through the double insulation of wire and the air space between, the discharge would snap across this point, and if it did not get a chance to do that it was very apt to

* Discussion of Paper by Milton E. Thompson.

go through the condenser coils. I tried to apply that principle to a much larger machine, and I found I could not make the condenser live under these conditions. It would perforate, although it was a remedy for the flashing. The tips of the brushes were practically quiet. It did not fulfil the conditions in practice, so that it lead to the trial of an air blast on the tips of the brushes, and the reasoning used in getting the air blast was this, that on the leaving of this segment there would be a small amount of current still fed from the segment to the brush, which would, as it were, tail off, and the sparks would be thicker at the brush and gradually thin out to a fine point and then stop. Then the segment would change polarity and go on to the other side. But, naturally, if the change of polarity was immediate on the cessation of that spark there might remain, as it were, from the spark, hot gas, which would enable the discharge to take place in the opposite direction, and that was a flash, which would be carried over from the arc. My idea was simply to blow a cold blast of air—as it were—to drive that spark away and insert, no matter how thin, a layer of cold air before the reversal was accomplished, and in that way to keep the insulation of the machine. That process is found effective even with a three coil commutator up to 3,500 or 4,000 volts with the pressure, of course, slightly increased as we rise.

Dr. Wm. E. GEYER: I have always thought that this machine is the most unique and interesting of all the machines built. I am very glad that a study of it has been made in this manner by Mr. Thompson. I should like to remark, however, that an exactly similar investigation was made as early as 1879 on a Brush machine of the class called open coil. The apparatus was just the same, a ballistic galvanometer being used, but instead of angles being taken every five degrees, they were only taken every ten degrees. The experiments were made more particularly to illustrate the action of any one particular coil, or of two coils in series, and, finally, of the machine as a whole. I might state that a short account of this was read at a meeting of the American Association for the Advancement of Science, at Boston, in 1880, and experiments were conducted by President Morton and Professor Thomas on some machines connected with the United States Light House Board.

Mr. E. W. RICE, jun.: In connection with the remark Professor Thomson made, that the flashing of the commutator was due to the re-establishment of the arc across the segment by the hot gases, I think it would be interesting to state a fact which I believe is not generally known, but which we discovered at the Thomson-Houston factory while experimenting with large lights for government use, with currents from 50 to 100 amperes, the potential difference being 50 volts and run in connection with a machine that would produce about 75 volts. We found that we could turn out the light and allow the arc to be completely extinguished for a full second; then switch on the current and the arc would be re-established. This was done repeatedly, showing that the hot gas was sufficiently conductive to re-establish the arc where there was a difference of potential of not more than 75 volts.

Professor THOMSON: I have seen that repeatedly where you could turn the switch and throw the current on again and the arc would re-establish itself, a complete dead space existing between the carbons for some interval. I would say just here, calling attention to the paper of Dr. Nichols, that we have an observation which goes along with this paper very prettily that here we have just the case of the stoppage and re-establishment, and the experiments mentioned prove that the alternations might have been very slow indeed, and with a considerable interval of interruption.

CORRESPONDENCE.

Applications of Aluminium.

The announcement made by Mr. Hall in his recent article in your journal on the properties of aluminium, to the effect that before long cooking vessels made of this metal will be largely thrown on the market, will, I feel sure, be received by many persons with genuine satisfaction. It has always seemed to me that one of the most obvious uses of aluminium lies in this direction, but at present the only means of obtaining such articles is to specially design and have them made at a, naturally, rather heavy cost. It goes without saying that on such a matter as the aluminium industry articles must first be supplied before a demand can be expected, and not *vice versa*; and it is, therefore, incumbent on those interested in this trade not merely to produce the metal, but also to see that articles *are* made of it. The production of the metal is really only half their business. I trust it is in contemplation to include amongst these cooking utensils the ornamental, economically beautiful, and convenient little piece of apparatus known as the breakfast-table egg-steamer. The anti-tarnishing property of the pure metal eminently recommends its application to this object. Glue pots made of aluminium would also be a luxury worth paying for. Most houses are furnished with one of these articles, but on the rare occasions when they are sought for, for use, they are usually discovered in a remarkably rusted and untidy condition, both inside and outside. If made of aluminium, however, a mere wipe with a cloth to remove dust would render them equal to new. With regard to cooking vessels proper, I may mention that about a couple of years ago I had a rather large vessel made for this purpose for a brother in India, but I understand that, owing to its incommodious size and to the want of a lid, the native servants cannot be induced to use it, and the vessel now serves as a very efficient wash-hand basin on camping expeditions.

There is another most useful household article for which aluminium is admirably suited, and it is one that I have never seen suggested, viz., coal vase tongs. I feel inclined to prophecy that so soon as these are made in quantity and thrown on the market they will be readily appreciated by the public. Some months ago I had a pair specially made for me by the Army and Navy Stores, and was charged the very reasonable sum of six shillings for them. Another pair were also made for me by the Alliance Aluminium Company. These tongs have fully realised all my expectations; they have kept perfectly bright through the past winter without perpetual rubbing, they have proved to be amply strong enough—a point upon which I had entertained some doubt—and lastly, but not least, they are most deliciously light.

I fear the applications of aluminium that I have been discussing scarcely come within the province of your journal, but you will perhaps stretch a point on this occasion on the consideration that every application of the metal indirectly furthers the electrical industry inasmuch as it is to this agency we owe its present commercial manufacture.

Legh S. Powell.

June 20th, 1891.

Induction in Multiple Core Cables.

We have read with great pleasure Mr. Jacob's remarks on the method of compensating for induction, devised by Mr. Gulstad and myself. It is, at the same time, interesting to see that Mr. Jacob has succeeded in doing the very same thing in an entirely different but most ingenious manner.

Mr. Jacob's beautiful device of eliminating the disturbances appears, however, only applicable in the special cases when the stations from which the work is carried on are situated at each end of the cable, so that the cores can be looped as described. This is, unfortunately, not practicable on those cables of the Great Northern Telegraph Company upon which we apply our compensating arrangement.

In China, the three-core cable (60 N.M.), mentioned in our paper, extends from Woosung to the island of Gutzlaff only, at which latter place none of the cores terminate, but where each of them is joined up with different cables extending east and south.

In Europe, the two-core cable (35 N.M.) referred to, lies between Marstrand (Sweden), and the Scaw; but there is no terminus at the Scaw, the one core is connected to Fredericia by means of a long land-line, and the other to Newcastle-upon-Tyne by a north sea cable.

It will thus readily be seen that no looping is possible, and that Mr. Jacob's system is unavailable for such lines.

We cannot quite see why our compensation by means of condensers and resistances, as shown in our paper, should not prove effective on comparatively speaking long cables.

Perhaps Mr. Jacob will enlighten us further on the subject.

P. Chr. Dresing.
K. Gulstad.

Copenhagen, *June 20th*, 1891.

Telegraphic Address: "Ageekay London." A B C Code. Telephone No. 517.

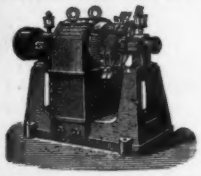
VOL. XXVIII. No. 709. [All Rights Reserved.] JUNE 26, 1891. [Registered at G.P.O. as a Newspaper.] PRICE FOURPENCE.

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW

LONDON: PUBLISHING OFFICE, 22, PATERNOSTER ROW, E.C.—SUBSCRIPTION per annum, Postage inclusive, in Great Britain, 19s. 6d.; to Countries in Postal Union, of the first class, 21s. 8d.; of the second class (Aden, India, Persia, &c.), 23s. 10d.—NEW YORK: D. VAN NOSTRAND, 23, Murray Street, and 27, Warren Street. PARIS: Madame VEUVE J. BOYVEAU, Librairie Etrangère, 22, Rue de la Banque. BERLIN: A. ASHER & Co., 5, Unter den Linden.

ELECTRIC LIGHT.—CENTRAL STATIONS and PRIVATE INSTALLATIONS fitted complete.

DYNAMOS.—ALTERNATORS & CONTINUOUS CURRENT MACHINES—KAPP'S PATENT.

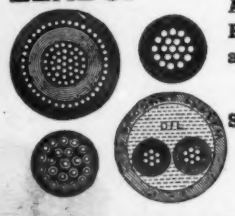


The KAPP "CENTRAL STATION" DYNAMO.
Arranged for Direct Coupling or Belt Driving.
"KAPP-WILLANS" COMBINATIONS.
Two-Pole, or Multipolar Type.

ARC LAMPS. SOLE MAKERS OF THE "BROCKIE-PELL," for

CONTINUOUS and ALTERNATING CURRENTS,
PARALLEL or SERIES WORKING.
SINGLE or DOUBLE CARBONS.
FOCUSSING or NON-FOCUSSING.

LEADS.—SUBMARINE, UNDERGROUND, AERIAL, TORPEDO, and ELECTRIC LIGHT CABLES and INSULATED LEADS of all descriptions.



Sole Licensees and Manufacturers in the United Kingdom of

BROOKS'S PATENT LIQUID SYSTEM of INSULATION for UNDERGROUND MAINS.

TRANSFORMERS,
SWITCHBOARDS,
ELECTRICAL MEASURING and TESTING APPARATUS and INSTRUMENTS, &c.
SWITCHES and ELECTRIC LIGHT FITTINGS, &c.,
Incandescent Lamps.

TELEPHONE No. 1010.
TELEGRAPHIC ADDRESS: "JUNO, LONDON."

JOHNSON & PHILLIPS,

14, UNION COURT, OLD BROAD ST., LONDON, E.C.
Works: CHARLTON, KENT.

All kinds of CARBONS for Arc Lamps.
Electric Bells, Pushes, Terminals,
SPEAKING INSTRUMENTS,
LIGHTNING ARRESTERS.

BATTERIES.

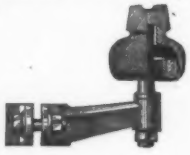
Sole Makers of Higgins's, Bichromate, Leclanché, &c., &c., Zinc and Carbon Plates, &c.

ACCUMULATORS.

The "D.P." Latest IMPROVED DESIGN, HIGH RATES OF DISCHARGE.

POLES, INSULATORS,

FITTINGS, &c., for TELEGRAPH, TELEPHONE and ELECTRIC LIGHT purposes.
JOHNSON & PHILLIPS'S Patent FLUID and TERMINAL INSULATORS.
SHACKLES, &c., and all descriptions of the ordinary form, in Porcelain or Brownware.



CABLE MACHINERY AND GEAR

Of all descriptions, for the complete equipment of TELEGRAPH CABLE FACTORIES and VESSELS, including Stranding, Closing, Tape, Yarn & Compound Serving and Rubber Covering Machines, &c.
PICKING-UP & PAYING-OUT MACHINERY, Dynamometers, Bow and Stern Gear, Cable Tanks, Telegraph Buoys, Grapnels, Centipedes, Mushrooms, Rope and Chain Fittings, Cable Leads, Cable Drums, Hauling Gears, Splicing and Jointing Tools, &c., &c., Steam and Hand Wire Sounding Machines for Deep and Shallow Water.
Sole Makers of TROTT & HAMILTON'S PATENT GRAPNEL ROPE and TROTT & KINGSFORD'S PATENT INDICATING GRAPNEL.

EVERY DESCRIPTION OF **TELEGRAPH PLANT AND MATERIAL.**

SILVER MEDAL, INTERNATIONAL ELECTRIC EXHIBITION, 1882.
International Inventions Exhibition, 1885, GOLD MEDAL for Machinery, SILVER MEDAL for Cables and Wire.

MANUFACTURERS
(By Patent Process)
OF
Silk and Cotton Covered WIRE and TAPE of all Sizes for Electrical purposes.

MANCHESTER WALTER T. GLOVER & Co SALFORD
LEADS & CABLES FOR
ELECTRIC LIGHTING

MANUFACTURERS
(By Patent Process)
OF
Specially Insulated Electric Light Leads, Cables and Multiple Wire for the various Systems.

VULCANIZED INDIA-RUBBER
CABLES AND WIRES
OF EVERY DESCRIPTION.

BEST QUALITY AND VALUE. PROMPT DELIVERY.

SPECIAL CONCENTRIC CABLES
FOR TOWN LIGHTING.

WALTER T. GLOVER & CO.,
Electrical Wire and Cable Makers,

Telegram Addresses: "Walter Glover," Salford. "Phonoscope," London.
SALFORD, MANCHESTER.
Established 1863. Telephone Addresses: No. 1,187, Manchester. No. 6691, London.

LONDON: 10, HATTON GARDEN, E.C. 1347

ELECTRICAL GOODS FOR EXPORT.

Installations shipped complete to any part of the world, as supplied for the Hotel Metropole, Sydney, for 800 lights, and many others. Export Merchants supplied on the best terms.

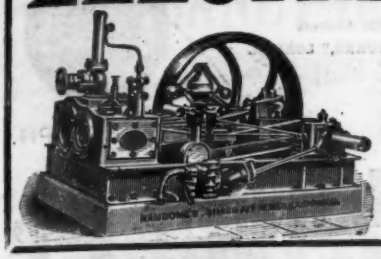
DRAKE & GORHAM,
2, PRINCES MANSIONS, VICTORIA STREET, S.W. 426
Telegraphic Address: "ACCUMULATOR, LONDON."

VERTICAL COMPOUND HIGH-SPEED ENGINE, C. S. TYPE
From 50 to 800 I.H.P. made.

ELECTRIC LIGHT ENGINES.
Over 250 Installations,
INCLUDING
STEAM SHIPS, WAR VESSELS, FACTORIES, MANSIONS, AND CENTRAL STATIONS,
HAVE BEEN ENGINED BY
BROWETT, LINDLEY & CO., LTD.,
SANDON ENGINE WORKS, **SALFORD, MANCHESTER.**
Patentees and Sole Makers of the **ACME GOVERNOR.** Hundreds are in use for Electric Light Engines. Send for Lists. 3785
Telegraphic Address: "SANDON, MANCHESTER."

ELECTRIC LIGHT ENGINES

ALL CLASSES OF ENGINES
MANUFACTURED BY



RANSOMES, SIMS & JEFFERIES, LD.

Catalogues and Prices on application.

ORWELL WORKS, IPSWICH; 9, GRACECHURCH STREET, LONDON.

THE UNITED ASBESTOS CO., LIMITED.

PIONEERS OF THE ASBESTOS TRADE.

The ONLY COMPANY in the World owning and working Asbestos Mines in both ITALY and CANADA. 4155

FINE ASBESTOS PAPER, for Dynamos, &c.
ASBESTOS TUBES & CEMENT, for Electric Light Leads.
ASBESTOS FIRE-PROOF PAINT, for protecting woodwork, troughs for leads, &c.
ASBESTOS MILLBOARD STRIPS, for ditto.
FINE ASBESTOS THREAD, for covering wires.
ASBESTOS COVERED WIRES.
PATENT SALAMANDER LUBRICANT, for Dynamos, &c.
PACKING, NON-CONDUCTING COVERING for Boilers, &c.

DOCK HOUSE, BILLITER ST., LONDON, E.C.
(*Late* 161, *Queen Victoria Street.*)

All Goods are made at our Works, near London, and are of the best possible description.

Specify "SALAMANDER" Brand.

Depôts: NEWCASTLE-ON-TYNE, Quay Side; MANCHESTER, 94, Deansgate; LIVERPOOL, 47 and 49, South John Street; GLASGOW, 60, West Howard Street; CARDIFF, 133, Bute Street; BRISTOL, Provident Buildings, Clare Street; ST. PETERSBURG, Gostinoe Dvor.

FREDERICK SMITH & CO.,

CALEDONIA WORKS, HALIFAX.

Contractors to Her Majesty's Government & Railway Companies

BEST REFINED TELEPHONE WIRE.

PATENT GALVANISED TELEGRAPH WIRE.

100 lb. COILS, HIGH CONDUCTIVITY.

SPECIALITY:—TELEGRAPH WIRE, TO ALL SPECIFICATIONS.

COPPER WIRE, hard drawn, high conductivity—long lengths. COPPER WIRE and TAPE for Lightning Conductors, &c. COPPER WIRE, all sizes for covering. STRAND WIRE all kinds GALVANISED HARD STEEL STRAND for Mechanical Telephones. 4154

F. WIGGINS & SONS, 10, TOWER HILL, E., and 102, MINORIES, E.C. LONDON,
MICA MERCHANTS, [*Telephone No.* 2242.
Manufacturers of Mica Goods for Electrical and ALL purposes.
CONTRACTORS TO HER MAJESTY'S GOVERNMENT. 4178

MICA.

PATENT OFFICE.

H. GARDNER.

166, FLEET STREET,

LONDON.

SUCCESSOR TO

Messrs. ROBERTSON, BROOMAN & CO.

PAMPHLET OF COSTS GRATIS.

FORTY-TWO YEARS' SPECIAL PRACTICE WITH INVENTIONS 4012

Wm. M. FOXCROFT

(*Successor to the late W. Foxcroft, also F. Lucas*),

Telegraph and Telephone Case Manufacturer,

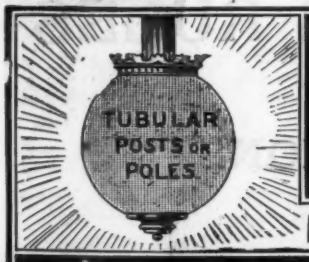
36, PERCIVAL STREET AND 9, SMITH STREET,

CLERKENWELL, LONDON, E.C.

(Offices—PERCIVAL STREET).

Lock and Block, Single Needle, Bell, Sounder, Perforator, Photometer, Telephone Cases, Battery Boxes, &c., &c.

PRIZE MEDALS, LONDON, 1851; PARIS, 1861. 165



TUBES

for "ELECTRICAL CONDUCTORS."

WROT IRON OR STEEL.

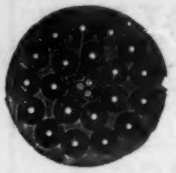
GAS, STEAM, WATER, BOILER TUBES AND FITTINGS.

PLAIN OR GALVANIZED

JOSEPH AIRD,

TUBE-WORKS, GREAT-BRIDGE, STAFFORDSHIRE.

LONDON OFFICE: 46, QUEEN VICTORIA ST E.C.



TELEPHONE No. 1734.

Telegraphic Address
"HENLEY'S WORKS," LONDON.

TELEPHONE. TELEGRAPH.

W. T. HENLEY'S TELEGRAPH WORKS CO.,

LIMITED,

27. MARTIN'S LANE, CANNON STREET, LONDON, E.C.

HENLEY'S

HIGH TENSION. LOW TENSION.

CABLES

FOR BOARD OF TRADE RULES

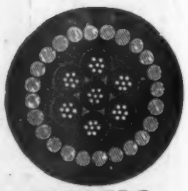
AND

FIRE OFFICE REGULATIONS.

WORKS:

NORTH WOOLWICH.

ELECTRIC LIGHT.



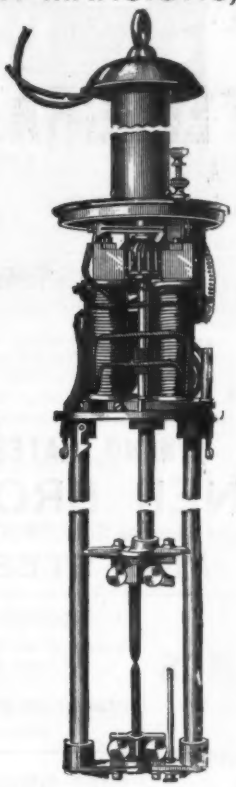
TORPEDO.

3992

THE PLANET ELECTRICAL ENGINEERING Co., LTD.

4, VICTORIA MANSIONS, WESTMINSTER.

PLANET ARC LAMP



The only Reliable Motor Lamp in the market for Street Lighting, Ships and interior of premises.

Positive Feed. Can be burnt in any position. All Engineers connected with Central Stations should see this Lamp.

FOR DIRECT OR ALTERNATING CURRENTS.

1902

Prof. SILVANUS THOMPSON says:—"This is the Electrical Engineer's Lamp."

FACTS!!

The Crompton-Howell Electrical Storage Co., Ltd., have erected, or are erecting,

THE CENTRAL STATION BATTERY

in connection with Central Stations supplying

300,000 LAMPS.

These Batteries act as a reserve for the above, or will run

50,000 LAMPS

direct without machinery.

QUOTATIONS FREE.

THE CROMPTON-HOWELL ELECTRICAL STORAGE COMPANY, LIMITED.

MANSION HOUSE BUILDINGS, LONDON, E.C.,

AND

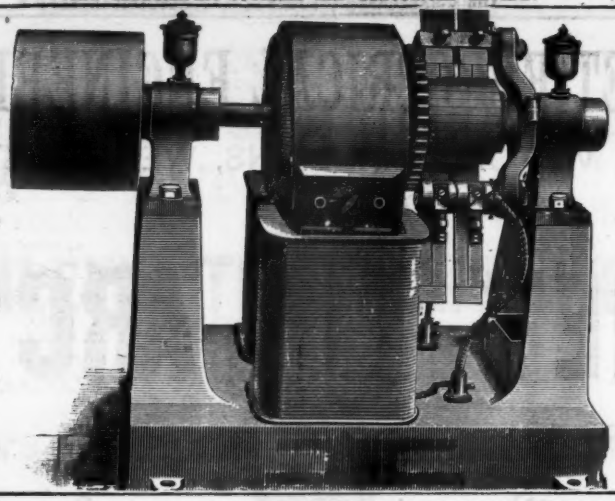
Works:—NEW DOCK, LLANELLY.

Telegraphic Address: "POROSITY," LONDON. Telephone 1,663.

391

BLAKEY, EMMOTT

AND CO. LIMITED.



DYNAMOS
For Incandescent or Arc Light,

Electro-Plating,
Transmission of Power,
&c.

HALIFAX, ENGLAND

831

J. D. F. ANDREWS & CO.,

Are prepared to undertake sub-contracts for the installation of concentric wiring for trade firms. They are making this system their entire speciality, and can assure a saving to contractors over the ordinary system.

Full information at 41 & 42, PARLIAMENT STREET, S W.

SPECIAL CHARCOAL IRON SHEETS. DYNAMO PLATES. TRANSFORMER STAMPINGS.

Charcoal Iron Wire.
Wrought Iron Magnet Forgings.
Sheet Steel, Tool Steel, Files, &c.
Bar Iron & Steel, Hoops, Plates, &c.

TURNER BROS.,

134, Upper Thames St., LONDON.

IRON AND STEEL.

Mild Steel & Bessemer Steel Forgings
Rolled and Forged Shafting.
Brass and Copper Rods and Tubes.
Wrought Iron and Steel Tubes.

EXCELSIOR

ELECTRO-PLATING DYNAMOS

For Nickel and Silver Plating, Brassing, Electro-typing, &c., as used by all the principal Platers in London.

PRICES FROM £6. Numerous Testimonials.

VATS, ANODES, AND COMPLETE OUTFITS.

CARL OPPERMANN, 2, Wynatt St., Clerkenwell.

3764

MANGANESE and CARBONS.

[ESTABLISHED 1868.]

[Specially prepared and Manufactured for every class of Electrical Work. (AGGLOMERATE BLOCKS). ALSO

TALC, slices, pencils ; MICA, lump, cut, and powdered.

GEO. G. BLACKWELL.

Works: GARSTON. Chief Office: 25 & 27, Irwell Chambers, LIVERPOOL.

Telegrams: "BLACKWELL, LIVERPOOL." *TELEPHONE 269.* 4087

CARBONS.

H. & F. CHAMBERLAIN,

Manufacturers of Pure Carbon Points, Tubes, Filters, Cells and Battery Plates of every description.

WORKS:-BARNSLEY.

Telegraphic Address:—"CARBON BARNSLEY." 3289

THOMAS BARRACLOUGH & CO., Ltd.,

Makers of all the most Improved Machinery for Electric Wire and Strand Covering, Lapping, Taping, Braiding, &c.,

ALSO FOR

STRANDING AND MAKING CABLES OF EVERY SIZE AND DESCRIPTION.

Globe Works, Rochdale Road, Manchester. 1980

THE BERNSTEIN ELECTRIC LAMP CO.,

(LIMITED),

2, MARLBOROUGH MANSIONS, VICTORIA ST., LONDON, S W.

OWNERS of the BERNSTEIN SYSTEM of ELECTRIC LIGHTING.

☞ The lamps of this Company are of low resistance, and entirely free from the claims of other companies. 1130

ELECTRIC WIRES.

Insulated Wire and Cables of every description for Electrical Instruments, Dynamo Machines, Electric Bells, Telephones, Electric Lighting, &c. &c.

UNITED ELECTRIC WIRE Co.,

14a, Clerkenwell Green, London, E.C. 1720

ANDREWS & PREECE, LTD.,

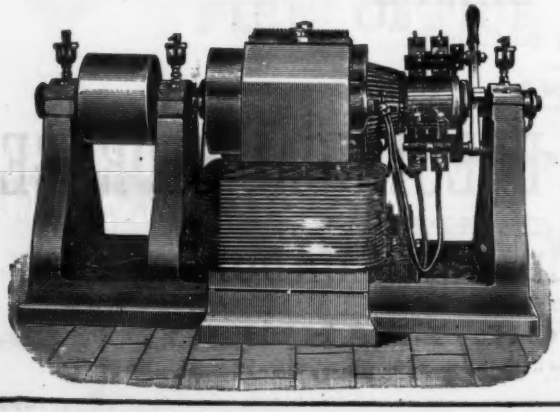
ELECTRICAL ENGINEERS & CONTRACTORS,

MANUFACTURERS OF THE

"PREECE" DYNAMO.

ARC LAMPS, SWITCHES, &c.

Estimates and Specifications prepared free of charge on application.



BOROUGH MILLS, MANCHESTER ROAD,

BRADFORD. 3826

JOHN WHITE & SONS,

Tanners, Curriers & Leather Merchants,

PARK ROAD LEATHER WORKS,

BINGLEY, YORKSHIRE.

AWARDS.—Leeds, 1873; Paris, 1878; Bradford, 1883; Amsterdam, 1883 Huddersfield, 1883; International Inventions, 1885 Colonial and Indian, 1886; Saltaire, 1887.

Telegraphic Address: "WHITESON'S, BINGLEY."

Patent V or Triangular and Square Leather Ropes. Specialities For Electric Machinery.

Selected by the Executive Council to supply the Leather Belting for the Machinery in the Electric Light Department of the Inventions Exhibition, 1885, and again in the same Department for the Colonial and Indian Exhibition, 1886.

FOR DRIVING THE MACHINERY IN THE ELECTRIC LIGHT DEPARTMENT OF THE

INTERNATIONAL INVENTIONS EXHIBITION OF 1885.

The following particulars relating to a portion of the Main Belts for Driving the Machinery in the Electric Light Department of the International Inventions Exhibition of 1885 may be of interest, showing such combined results in Belt Driving as have probably never been previously attained:—

	Length.	Width.	Speed.	Transmitted.	
No. 1—	70 feet	× 10 inches	2,585 feet per minute	120 I.H.P.	TOTAL 1,180 I.H.P.
No. 2—	73 feet	× 15 inches	2,585 feet "	170 "	
No. 3—	90 feet	× 16 inches	2,270 feet "	200 "	
No. 4—	86 feet	× 24 inches	2,585 feet "	320 "	
No. 5—	86 feet	× 15 inches	2,585 feet "	170 "	
No. 6—	86 feet	× 15 inches	2,585 feet "	170 "	

JOHN WHITE & SONS supplied the Main Driving Belts at

THE BRADFORD TECHNICAL SCHOOL EXHIBITION, 1882.
" HUDDERSFIELD " " " 1883.
" SALTAIRE EXHIBITION - - - - 1887.

Being awarded GOLD MEDALS ON ALL THE OCCASIONS for complete efficiency.

4081

STIFF & SONS,

LAMBETH LONDON,

MANUFACTURERS OF

PLUMBAGO CRUCIBLES,

Testimonials show 30 to 50 meltings each.

STONEWARE INSULATORS,

LARGE STOCK OF ALL PATTERNS AND SIZES.

SWITCH BLOCKS, FUSE BLOCKS,

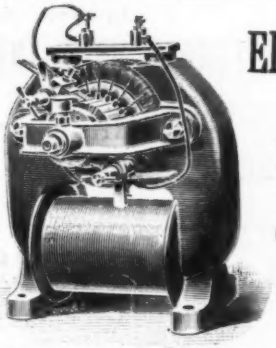
Vitrified Tubes for Electric Wires, Porous Cells, Battery Jars Every kind of Electrical Stoneware.

AWARDS:—PARIS AND VIENNA ELECTRICAL EXHIBITIONS.

1045

CUTTRISS, WALLIS & CO., LTD.,

Electrical Engineers & Manufacturers.



ELECTRO-MOTORS

From $\frac{1}{50}$ to 50 H.P.

DYNAMOS

For all purposes.

COMPLETE PLANT FOR ELECTRIC LIGHT AND TRANSMISSION OF POWER.

Contractors for the erection of Bells, Telephones, &c

3095

ELMWOOD ELECTRICAL WORKS & I, BOND PLACE, LEEDS.

LIGHT, POWER & TRACTION

(IMMISCH, SPRAGUE & JULIEN PATENTS).

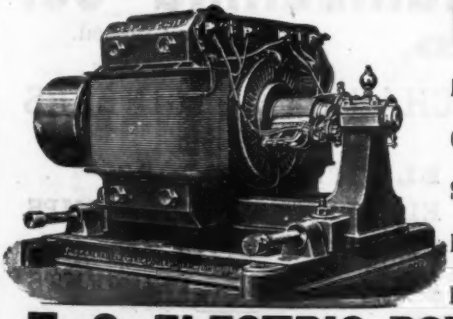
DYNAMOS for Electric Lighting, Transmission of Power, &c.

MOTORS FOR ELECTRIC PUMPING, HAULING, VENTILATING, &c., IN MINES.

ELECTRIC LIGHTING IN ALL ITS BRANCHES.

Contracts undertaken for Wiring, and all descriptions of work.

ELECTRIC LAUNCHES ON THAMES AND WINDERMERE FOR SALE OR HIRE.



ELECTRIC TRACTION

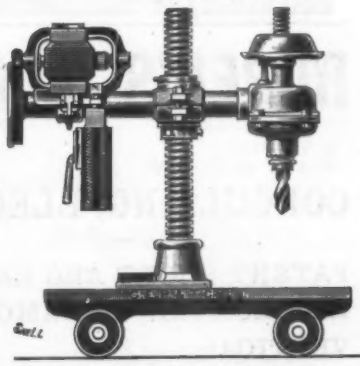
Estimates and Full Particulars on Application.

Agents for Scotland: Messrs. MAVOR and COULSON, 56, George Square, Glasgow.

Yorkshire and North of England: Mr. C. A. SHUTE, Portland House, Eastbourne, Darlington.

South Wales: Mr. E. J. HOWARD, 34, West Bute Street, Cardiff.

Lancashire, Cheshire and North Wales: Mr. RICHARD WHITE, Widnes.



Immisch Motor in Combination with NEWALL'S PATENT PORTABLE DRILL.

T. G. ELECTRIC POWER & TRACTION COMPANY, LD.,

(Late M. IMMISCH & CO.)

Head Office: 35, NEW BROAD STREET, E.C. Works: KENTISH TOWN, N.W.

TELEPHONES
AND
TELEPHONIC APPARATUS
OF EVERY DESCRIPTION KEPT IN STOCK.

INSULATORS, IRON WORK AND ALL MATERIALS FOR TELEPHONE & TELEGRAPH LINE CONSTRUCTION AND RENEWAL IN STOCK.

Estimates and Plans FREE for Supplying, Fixing, and Maintaining Telephones and Lines any distance, Town or Country. 4385

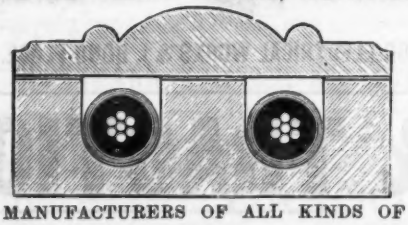
UNIVERSAL TELEPHONE CO., 11, Queen Victoria St., London, E.C.

BAYLEY BROTHERS, WALSALL,
MANUFACTURERS OF

ELECTRICAL FITTINGS IN BRASS, BRONZE AND SILVER.
ACORN SOCKETS
AND
EVERY STYLE OF LAMPHOLDERS
(Under License from Edison & Swan).
STOKE HOLE AND BULKHEAD LAMPS,
PORTABLE HAND LAMPS
AND
ALL KINDS OF SHIP FITTINGS.

BEST MATERIAL AND WORKMANSHIP GUARANTEED.
Illustrated Price Lists on application. 4480

C. FRAZER'S EXECUTORS,
PALACE PLAIN WORKS, NORWICH.



MANUFACTURERS OF ALL KINDS OF
ELECTRIC CABLE CASINGS
AND
COVERINGS.
SPECIAL PATTERNS ON SHORTEST NOTICE.
Lowest Prices on application. 4277
1000 FEET AND UPWARDS CARRIAGE PAID TO LONDON.

WILKE'S POLE INDING PAPER
SOLE IMPORTERS PER BOOK 1/6
O. BEREND & Co. 61. FORE ST. LONDON EC

SHEPPARD, ALLARTON & MADELEY,
CLEMENT STREET, BIRMINGHAM,

MANUFACTURERS OF
BELLS OR GONGS
Of all Sizes and of Best Quality and Finish,
FOR ELECTRICAL PURPOSES. 3181

WILLIAM WOOD & CO.,
ALBERT STREET WORKS, BURSLEM
MANUFACTURERS OF
CHINA AND PORCELAIN SWITCHES,
Screwed and Plain,
SUSPENDERS, CEILING ROSES, BASES,
LAMPHOLDERS, CUT-OUTS 2804
AND ALL CHINA FITTINGS USED BY ELECTRICIANS.

ROPER'S ELECTRICAL ENGINEERING CO.
Managing Directors:
A. W. HINE
F. J. A. MATTHEWS.
BRADFORD, [Limited.]
CONSULTING, ELECTRICAL, MECHANICAL ENGINEERS

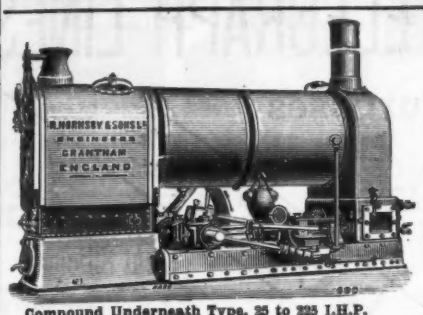
PATENT SHORT ARC LAMPS.
HORIZONTAL DYNAMOS.
VERTICAL ,,
OVERTYPE ,,

ELECTRO MOTORS.
ELECTRIC MINING PUMPS.
ELECTRIC LAUNCHES.
MEASURING INSTRUMENTS.

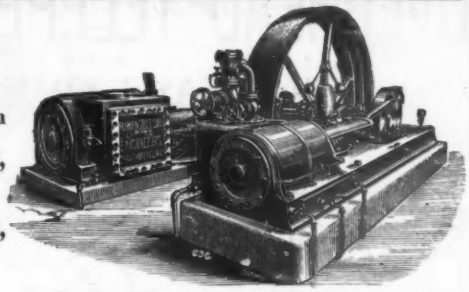
Slow Speed, No Sparking,
High Efficiency, Inexpensive.

GOLD MEDAL AWARD. 4308
CATALOGUE AND PRICES ON APPLICATION.

R. HORNSBY & SONS, LTD.



CATALOGUES
and
ESTIMATES
Post free on application
to
Spittlegate Iron Works,
GRANTHAM;
or
84, LOMBARD STREET,
LONDON.



Compound Underneath Type, 25 to 225 I.H.P.

Compound Coupled Horizontal Type, 30 to 300 I.H.P.

PERFECT GOVERNING A SPECIALITY.

ENGINES FOR ELECTRIC LIGHT. 4230

JULIUS SAX

(ESTABLISHED 1855),

ELECTRICAL ENGINEER AND ELECTRIC LIGHT CONTRACTOR,

RIDGMOUNT STREET, STORE STREET, LONDON, W.C.

SPECIALITIES.—Electric Bells, Burglar Alarms, Patent Automatic Fire Alarms, Watchmen's Clocks, Water Gauges, Electric Indicator and Light for Carriages, Billiard Markers, Gas Lighters, Lightning Conductors, Telephones, Automatic Call Bells for Fire Stations, General Electric Lighting.

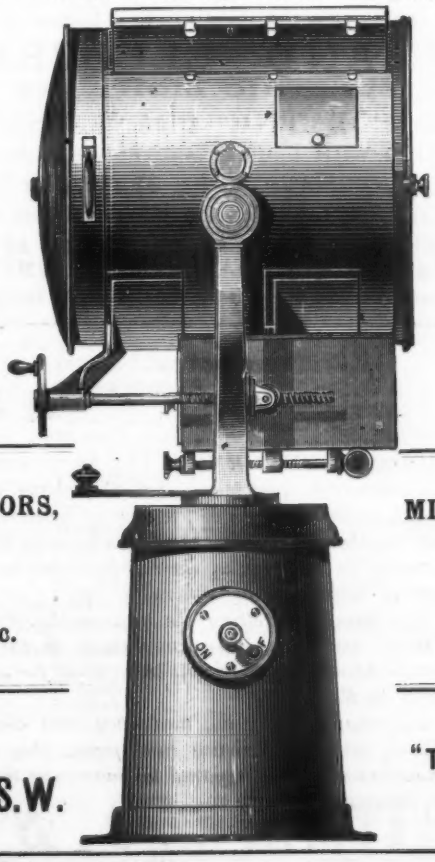
ESTIMATES FREE ON APPLICATION. 4188

Telephone No. 3848. **Telegrams: "SAX, LONDON."**

C. A. PARSONS & CO., HEATON WORKS, NEWCASTLE-ON-TYNE,

ELECTRICAL ENGINEERS AND CONTRACTORS,

Manufacturers of STEAM TURBINE DYNAMOS, also DYNAMOS Driven by Belt Gearing and for Coupling Direct to Engines.



CONTRACTORS for COMPLETE CENTRAL ELECTRIC LIGHTING STATIONS.

SEARCH LIGHT PROJECTORS, MOTORS, ARC LAMPS, TRANSFORMERS, &c.

MIRRORS! MIRRORS!! MIRRORS!!!

London Office:

66, VICTORIA STREET, S.W.

Telegraphic Addresses:
"TURBO, NEWCASTLE-ON-TYNE."
"DUNAMIS, LONDON."

BEST WIRE
FOR
OVERHEAD TELEPHONE & TELEGRAPH LINES
And all Electrical Purposes.

PHOSPHOR BRONZE CASTINGS, &c.

Patent Phosphor Bronze for Springs, Ropes, Screws, Rods, Sheets, &c., Bearings, Bushes, and other wearing parts of Machinery

Patent Silicium Bronze and Silicium Copper Wire of Great Tensile Strength and High Conductivity for Telephone and Telegraph Lines & other Electrical purposes.

SILICIUM BRONZE. PHOSPHOR BRONZE.

PHOSPHOR BRONZE · VULCAN · PHOSPHOR · HARD METAL

SOLE PROPRIETORS
Of the British and Colonial Patents,
THE PHOSPHOR BRONZE CO.,
LIMITED,
87, Sumner Street, Southwark, London, S.E.

BEWARE OF SPURIOUS IMITATIONS, FALSE REPRESENTATIONS, AND INFRINGEMENTS OF OUR PATENT RIGHTS.

REID BROTHERS,
12, Wharf Road, City Road, London, N.,
TELEGRAPH AND PNEUMATIC ENGINEERS AND CONTRACTORS
FOR THE SUPPLYING, ERECTING LAYING DOWN AND MAINTENANCE OF OVERHEAD AND UNDERGROUND WIRES FOR
TELEGRAPHS AND ELECTRIC LIGHTING.
COMPLETE ELECTRIC LIGHT INSTALLATIONS.
PNEUMATIC TUBES FOR THE TRANSMISSION OF PAPERS, &c.,
FITTED WITH ENGINES AND PUMPS COMPLETE.
REID BROS.' "PATENT" PNEUMATIC CASH SYSTEM for the transmission of COINS, &c.
Makers of Radcliffe's Patent Electrical Signal-Locking Apparatus, and Patent Electrical Passenger and Guard Communication.
CONTRACTORS TO H.M. GOVERNMENT FOR SUBMARINE MINING APPARATUS AND ALL ELECTRICAL TESTING AND TELEGRAPH INSTRUMENTS.
Manufacturers of Submarine Cables, Wire, Iron Poles, Instruments, Batteries, Insulators, and Stores of every Description. 4222

TEDDINGTON,
MIDDLESEX,
May, 1891.

Messrs. SWINBURNE & CO. beg to announce to their numerous customers that they have now a considerable stock of all the usual sizes of transformers. By still further enlarging their works they have at last succeeded in catching up their orders and are now prepared to deliver transformers on receipt of order. While very much regretting the unavoidable delay of which some customers have complained in the past, they feel confident that there will be no cause for similar complaints in the future.

Knowing, as they do, that they can challenge competition, both in efficiency and price, they solicit further orders and are prepared to guarantee the most prompt attention.

Fireproof Cases Extra.

Lamps. (50-W.)	H.P.	Price. £	s.	d.
50	2	8	18	0
100	4	12	15	0
150	6	17	17	0
200	8	20	0	0
250	10	24	0	0
300	12	30	0	0
400	16	35	0	0
500	20	40	0	0
750	30	55	0	0
1000	40	70	0	0

Above 400 lights not stocked.

3688

INDEX TO ADVERTISEMENTS.

The names of Advertisers, whose announcements are ordered for a series, are entered under any one Heading in this Index free of charge, but if repeated under other headings, 6d. per week is charged for each additional entry.

Accumulators. PAGE
Crompton-Howell Elec. S. Co. ... 5
Drake & Gorham 2
J. Stiff & Sons (Boxes only) ... 7
Woodhouse & Rawson United ... 13

Arc Lamps.
Johnson & Phillips 1
F. M. Newton & Co. 19
Planet Elec. Engineering Co. ... 5
Poole & White ... ... *Sup.* 13
Woodhouse & Rawson United ... 13

Asbestos.
United Asbestos Co. 3

Auctioneers and Valuers (Mechanical).
Wheatley Kirk, Price & Goulty *Sup.* 9

Batteries.
Birmingham Tele. Factory *Sup.* 5
Electric Stores, Ltd. ... ...
India-Rubber Co.... 24
Johnson & Phillips 1
Telegraph Mfg. Co. ... *Sup.* 1
Weymersch Battery ... *Sup.* 15
Woodhouse & Rawson United ... 13

Battery Jars.—J. Bourne & Son ... 15
J. Stiff & Sons 7

Bells.—Birmingham Tele. Factory *Sup.* 5
General Elec. Co., Ld. ... *Sup.* 8
Poole & White ... ... *Sup.* 13
Sheppard, Allarton & Madeley... 8
Woodhouse & Rawson United ... 13

Belting.—John White & Sons ... 7
Webb & Sons ... ...

Books.
Crosby Lockwood & Son *Sup.* 12
Longmans & Co. ... ...
E. & F. N. Spon ... ... *Sup.* 12
Whittaker & Co. ... *Sup.* 12

Cabinet Work.—W. M. Foxcroft ... 3

Castings.—J. & J. Hughes 14
Phosphor Bronze Co. 10

Chemicals.—G. G. Blackwell ... 6
G. Boor & Co. 21

Dynamos.—Andrews & Preece ... 6
Austin & Myers 19
Gülcher Electric Light & P. Co. 15
T. L. Hemming & Co. 14
J. H. Holmes & Co. ... *Sup.* 9
Johnson & Phillips 1
Laurence, Scott & Co. 23
F. M. Newton & Co. 19
C. Oppermann 6
C. A. Parsons & Co. 9
Roper's Electrical Eng. Co. ... 8
Ernest Scott & Mountain ... 21
Woodhouse & Rawson United ... 13

Ebonite.—Harburg I. Rbr. Comb Co. *Sup.* 9
D. Moseley & Sons 18

Electrical Engineers and Contractors.
Acme Electric Works 17
J. D. F. Andrews & Co. 6
Andrews & Preece 6
Appleton, Burbey & Williamson *Sup.* 14
Blakey, Emmott & Co. 6
Birmingham Tele. Factory *Sup.* 5
Brush Electrical Engineering Co. 12
Callender's Bitumen Tel. &c. Co. 15
Charlesworth, Hall & Co. ... 16
Crompton & Co. ... ... *Sup.* 16
Drake & Gorham 2
Elliott Bros. ... ... *Sup.* 16
General Elec. P. & Traction Co.... 7
W. T. Goolden & Co. ... *Sup.* 11
India-Rubber & Telegraph Works Co. 24
Johnson & Phillips 1
Laurence, Scott & Co. 23
Paterson & Cooper 23
Rashleigh Phipps & Dawson ... 12
C. A. Parsons & Co. 9
Reid Bros. 10

Electrical Engineers, &c.—*Cont.* PAGE
Julius Sax 9
Ernest Scott & Mountain ... 21
Ronald A. Scott ... ... *Sup.* 4
Sharp & Kent ... ...
Swinburne & Co. 10
Telegraph Mfg. Co. ... *Sup.* 1
Western Electric Company *Sup.* 16
Woodhouse & Rawson United ... 13

Electric Light Carbons.
H. & F. Chamberlain 6
Genl. Elec. Co., Ld. (G. Binswanger) *Sup.* 8
Johnson & Phillips 1
Poole & White ... ... *Sup.* 13
Woodhouse & Rawson United ... 13

Electric Light Fittings.
Appleton, Burbey & Williamson *Sup.* 14
Bayley Bros. 8
Benham & Froud... ... ...
Brompton Elec. Fittings Co. *Sup.* 3
Dorman & Smith 11
Electrical Accessories Co. ...
Faraday & Son 12
Genl. Elec. Co., Ld. (G. Binswanger) *Sup.* 8
The Paiste Switch ... *Sup.* 3
Rashleigh Phipps & Dawson ... 12
Poole & White ... ... *Sup.* 13
B. Verity & Sons ... ... *Sup.* 10
Walsall Electrical Co. ... ...
Woodhouse & Rawson United ... 13

Engines for Electric Light.
W. H. Bailey & Co. 20
G. E. Belliss & Co. ... ...
Browett, Lindley & Co. 2
Campbell Gas Engine ... *Sup.* 15
Davey, Paxman & Co. 12
Greenwood & Batley ... ...
Griffin Gas Engine ... ...
R. Hornsby & Sons 9
Marshall, Sons & Co. 21
Priestman's Oil Engine ... *Sup.* 2
Ransomes, Sims & Jefferies ... 3
Robey & Co. 20
Stockport Gas Engine ... ...
Hayward Tyler & Co. ... ...
Willans & Robinson ... ...

Exhibition.
Crystal Palace ... ... *Sup.* 2

Fibre.—David Moseley & Sons ... 18

Glass.—Genl. Elec. Co. (G. Binswanger) *Sup.* 8
Poole & White ... ... *Sup.* 13
Woodhouse & Rawson United ... 13

Incandescence Lamps.
Bernstein Electric Lamp Co. ... 6
Brush Electrical Engineering Co. 12
Poole & White ... ... *Sup.* 13
Sunbeam Lamp Co. ... ...
Woodhouse & Rawson United ... 13
Woodside Electric Co. 14

India-Rubber.
India-Rubber, G. P. & Tel. Wks. Co. 24
D. Moseley & Sons 18

Insulators, &c.
Birmingham Tele. Factory *Sup.* 5
Bourne & Son 15
Poole & White ... ... *Sup.* 13
Price, Sons & Co.... ... ...
Stiff & Sons 7
Telegraph Mfg. Co. ... *Sup.* 1
Woodhouse & Rawson United ... 13

Iron and Steel.—Turner Bros. ... 6

Lead Pipe Machinery.
Geo. Edward & Co. 16

Lubricants.—W. H. Willcox & Co.... ...

Magnet Steel.—G. P. Wall... ... 19

Manufacturing Electricians.
Birmingham Tele. Factory *Sup.* 5
Croggon & Co. ... ...
Dorman & Smith 11
Elliott Bros. ... ... *Sup.* 16

Manufacturing Electricians—*Cont.* PAGE
Hartmann & Braun ... *Sup.* 7
International Electric Co. *Sup.* 15
Rankin Kennedy 19
Keys' Electric Co. ... *Sup.* 6
King, Mendham & Co. ... ...
Laurence, Scott & Co. 23
Nalder Bros. ... ... *Sup.* 7
Jas. Pitkin... 14
Poole & White ... ... *Sup.* 13
Richard Frères ... ... *Sup.* 1
Julius Sax 9
Telegraph Mfg. Co. ... *Sup.* 1
Walsall Electrical Company ...
Jas. White... ... ...
Woodhouse & Rawson United ... 13

Mica.—F. Wiggins & Sons 3

Motors.
Cuttriss, Wallis & Co. 7
Gülcher Electric Light & P. Co. 15

Patent Agents.—H. Gardner ... 3
J. G. Lorrain ... ... *Sup.* 10

Pole Finding Paper.
O. Berend & Co. 8

Poles.—Joseph Aird (Wrought Iron & Steel) 3
Johnson & Phillips (Wood and Iron) 1

Porcelain Appliances.
Dorman & Smith 11
Genl. Elec. Co., Ld. (G. Binswanger) *Sup.* 8
Poole & White ... ... *Sup.* 13
Taylor, Tunnicliff & Co. ... ...
W. Wood & Co. 8
Woodhouse & Rawson United ... 13

Porous Cells.—J. Stiff & Sons ... 7

Railway Signals.—Saxby & Farmer 12

Schools, &c.—School of Elec. Eng.
Elecl. Standardising, &c., Inst. *Sup.* 2

Screws.—Davis & Timmins ... 22
A. Stokes & Co. 18

Stampings.—Harold & Jenkins *Sup.* 2

Telegraph Engineers.
Birmingham Tele. Factory *Sup.* 5
Johnson & Phillips 1
Julius Sax 9
Telegraph Mfg. Co. ... *Sup.* 1

Telephones.
J. T. Gent & Co. ... ... *Sup.* 7
Universal Telephone Co. ... 8

Tools, &c.—Chas. Churchill & Co. ... 15
Square Drilling Machine Co. ... 21

Tubes.—Joseph Aird 3

Turbines.—F. Nell ... ...

Wire (Covered).
Birmingham Tele. Factory *Sup.* 5
Fowler-Waring Cables Co. ... 16
W. T. Glover & Co. 2
W. T. Henley's Telg. Works Co. 4
Hooper's Tele. & In.-rub Works *Sup.* 1
London Electric Wire Co. *Sup.* 1
Okonite Company ... *Sup.* 3
Phillips Bros. 23
Phosphor Bronze Co. 10
Poole & White ... ... *Sup.* 13
Telegraph Mfg. Co. ... *Sup.* 1
United Electric Wire Co. ... 6
Woodhouse & Rawson United ... 13

Wire (Uncovered).—Davis & Timmins 22
Ramsden, Camm & Co. 15
F. Smith & Co. 3

Wire Covering Machinery.
T. Barraclough & Co. 6

Wood Casings.
C. Frazer's Executors 8
Genl. Elec. Co., Ld. (G. Binswanger) *Sup.* 8
Poole & White ... ... *Sup.* 13
Vigers Bros. ... ...
Woodhouse & Rawson United ... 13

MISCELLANEOUS ADVERTISEMENTS *relating to Situations, Articles for Sale and Wanted, &c., &c., appear on Sup.* 9 *(middle of paper).*

CROMPTON & CO., LIMITED, SEE SUP. 16.

Telephone No. 5211.

FARADAY & SON'S

ELECTRIC LIGHT FITTINGS.

SPECIALITIES IN DOMESTIC LIGHTING.—Decorative Fittings, Reading Lamps, Vertical and Lateral Counterweight Pendants, Picture Lights, Adjustable Reflectors, Fittings convertible for wall or table use, Universal Jointed Brackets, &c.

8, BERNERS STREET, W.
Works: 9 & 10, NEWMAN MEWS.

Telegrams: "Faraday," London.

INTERLOCKING THE LOCK AND BLOCK.

The Board of Trade have again and again urged the necessity of combining the "Lock" and "Block" systems by actual connection between the Telegraph Instruments and Locking Levers, to effect "inter-dependent working." This great improvement, together with Supplementary Automatic Train Action, has been reliably accomplished and brought into practical use on several lines by Messrs. SAXBY & FARMER, under protection of various Patents granted or assigned to them. *Diploma of Honour (the Highest Award), Edinburgh, 1890.* For Particulars, Plans, and Estimates, apply to

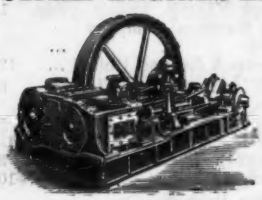
SAXBY & FARMER, Railway Signal Contractors Canterbury Road, KILBURN, LONDON, N.W.

Manufacturers of Railway Signals, Cabins, Interlocking Levers, Block Instruments, and Signal Work of every description, Electrical and Mechanical. 1443

DAVEY, PAXMAN & Co., Engineers, COLCHESTER,

Devote special attention to

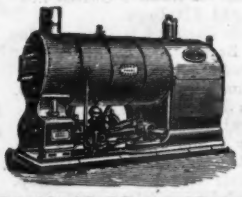
STEAM ENGINES AND BOILERS REQUIRED FOR ELECTRIC LIGHT INSTALLATIONS.



Compound Fixed Engine.
8 to 100 H.P. nom.

Competitive Trials at Newcastle, JULY, 1887 open to all Makers. The only prizes offered by the R.A.S.E. for Steam Engines, &c. £300 for Best Compound Portable Engine, £100 for Best Single P. & C. Portable Engine, were awarded to D. P. & Co. Economy of Fuel, Excellence of Design, and Smooth and even Regular Working. This record is 24 per cent. lower than that of the most Economic Engine at the Cardiff Trials in 1878.

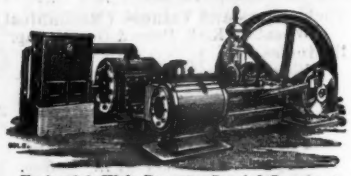
Telegraph Address:—
"PAXMAN, COLCHESTER."



Patent Semi-fixed Compound Engine and Boiler. 8 to 70 H.P. nom.

Catalogues, Price Lists, and full particulars Post Free on application to

MAKERS OF
Portable Engines, Semi-Portable Engines, Semi-Fixed Engines and Boilers, Horizontal Winding Engines, Horizontal Engines, Vertical Engines and Boilers, Horizontal Winding Engines and Boilers, Vertical Winding Engines and Boilers, Compound Semi-Fixed Engines and Boilers, Compound Horizontal Fixed Engines, Cornish, Lancashire, and other Boilers.



Horizontal High Pressure Coupled Compound Engine. 12 to 100 H.P. nom.

PARIS EXHIBITION, 1889.

D. P. & Co. have been awarded Two Gold Medals and One Silver Medal for their Steam Engines and Boilers.

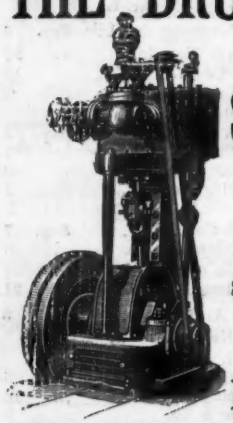
D. P. & Co.'s Engines are the cheapest, most durable and most reliable in the market.

DAVEY, PAXMAN & CO., Engineers, COLCHESTER.

LONDON OFFICE: 78 [late 139], QUEEN VICTORIA STREET, E.C. 2044

THE BRUSH ELECTRICAL ENGINEERING CO.,

LIMITED.



SINGLE CYLINDER AND COMPOUND ENGINES.

Efficiency, Simplicity, Durability, Extra Large Wearing Surfaces, Special Lubricating Arrangements. Perfect Accessibility for Adjustment.
From 6·6 I.H.P. upwards.

SPECIAL TERMS TO THE TRADE.

Works: LAMBETH, LOUGHBOROUGH AND VIENNA. 3820

Head Office: 112, BELVEDERE RD., LAMBETH, S.E.

ELECTRIC LIGHT FITTINGS

The Best, Cheapest & most Artistic display of fittings in London

(TRADE SUPPLIED)

Rashleigh Phipps & Dawson.

ELECTRIC LIGHT ENGINEERS AND CONTRACTORS.

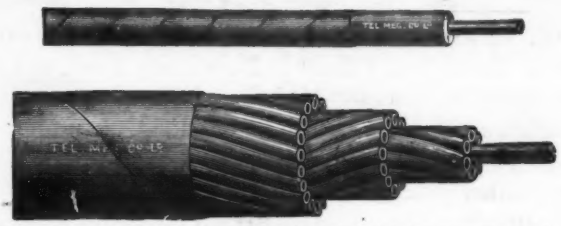
COMPLETE INSTALLATIONS, OR WIRING ONLY CARRIED OUT PROMPTLY, ALL WORK GUARANTEED.

Offices & Show Rooms 53 Berners Street W.

WORKS: WELLS MEWS, OXFORD ST W.

TELEPHONE No 3975 TELEGRAMS "DETECTOR, LONDON" 3211

Telephone. CABLES and WIRES. Telegraph.



THE TELEGRAPH MANUFACTURING COMPANY (LIMITED)

Insulated with GUTTA-PERCHA, VULCANISED RUBBER, INDIA-RUBBER and COTTON, &c., &c.

UNDERGROUND; OFFICE; AERIAL.

HELSBY, NEAR WARRINGTON; AND 11, QUEEN VICTORIA ST., E.C.

TELEPHONE FLEXIBLE CORDS a Speciality.

4485

RICHARD FRÈRES,

43, LONDON WALL, LONDON, E.C.

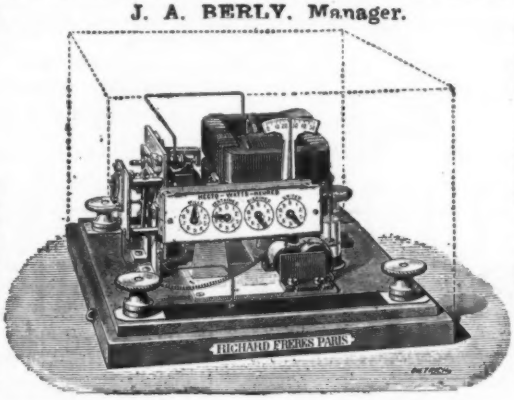
J. A. BERLY, Manager.

PATENT ELECTRICITY METER

(KILO-WATT HOURS),

For Direct or Alternating Currents.

Our Electricity Meters are strong, cannot get out of order, and are guaranteed. They require no attention nor periodical winding, the independent and interchangeable clockwork with which they are provided being automatically wound up at every other 15 seconds by a shunt current of a duration of $\frac{1}{50}$th second. They are easy of inspection. Their individual consumption does not exceed $\frac{1}{10}$th ampere, and they start with a consumption equal to $\frac{1}{50}$th of their capacity. These meters can be made to register differentially and are therefore useful for measuring both the charging and discharging of accumulators. *The correctness of their indications is guaranteed to within one per cent.* Their price is 40 per cent. lower than that of any other meter in use. Large discount on quantities.



PRICES.

10 Amperes		£7	500 Amperes,		£15
50	,,	£8	750	,,	£18
100	,,	£9	1,000	,,	£26
250	,,	£12	1,500	,,	£32

For full particulars, &c., apply to Richard Frères, 43, London Wall, London, E.C. Illustrated Catalogue of Self-Recording Instruments free on application.

4345

HOOPER'S TELEGRAPH AND INDIA RUBBER WORKS.

Offices: 31, LOMBARD STREET, LONDON, E.C. Works: MILLWALL DOCKS, E.

Manufacturers of TELEGRAPH CABLES,
HOOPER'S CORE and Insulated Wire for ELECTRIC LIGHT
AND OTHER PURPOSES.
India Rubber Sheet and Tape, Pure or Vulcanized.
Jointing Materials for Electric Light Wires, &c.

THE

LONDON ELECTRIC WIRE COMPANY,

ANCHOR WORKS, PLAYHOUSE YARD, GOLDEN LANE, LONDON E.C.

Manufacturers of

COVERED WIRES & CABLES

OF ALL DESCRIPTIONS

FOR ELECTRICAL INSTRUMENTS, ELECTRIC LIGHTING,

BELL AND TELEPHONE WORK. &c. m

CRYSTAL PALACE ELECTRICAL EXHIBITION, 1891-1892.

AN ELECTRICAL EXHIBITION, on the same lines as that which proved such a brilliant success in 1881, will be opened at the Crystal Palace in November, 1891, and be continued for some months. No charge will be made for space. Medals and Certificates will be awarded.

Applications for space must be made on printed forms to be obtained, post free, together with prospectus, from the MANAGER, Crystal Palace, S.E., or from Mr. R. APPLEGARTH, of 11, Queen Victoria Street, E.C., who has been appointed Assistant Engineer to the Exhibition.

HENSHAW RUSSELL, *Manager.*

CRYSTAL PALACE, *May*, 1891. 4444

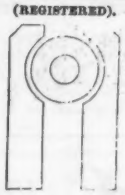
THE ELECTRICAL
STANDARDIZING TESTING & TRAINING INSTITUTION

THE WORK UNDERTAKEN BY THIS INSTITUTION IS AS FOLLOWS:—

Standardizing Electrical Instruments.
Testing Electrical Instruments.
Inspecting Installations.
Reporting upon New Inventions and Apparatus.
Training Electrical Engineers.
Experimenting on behalf of Inventors.

For full particulars apply to the Secretary, Faraday House, Charing Cross Road, W.C. 4311

TRADE MARK. (REGISTERED).

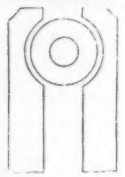


HAROLD & JENKINS,

30 & 31, St Swithin's Lane, LONDON, E.C.

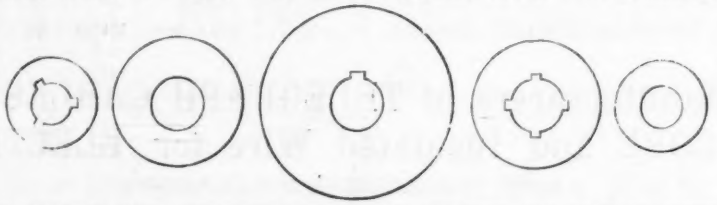
Telegraphic Address: "SYMBOLIZE, LONDON." Cable Address: "JOCANTRY, LONDON."

TRADE MARK (REGISTERED).



STAMPINGS
IN
BEST CHARCOAL IRON FOR ELECTRICAL MACHINES
AND FOR ALL TYPES OF DYNAMOS AND TRANSFORMERS.

ARMATURE DISCS from 2 to 50 in. diam., with any Size of Centre Hole and keyways.



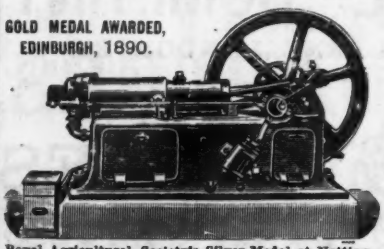
TRANSFORMER STAMPINGS in all Shapes & Gauges.

ALL OUR STAMPINGS ARE SUPPLIED FLAT, FREE FROM BURRS, WELL ANNEALED AND TRUE TO GAUGE, AND IN ALL GAUGES SUITABLE FOR ELECTRICAL PURPOSES.

Enquiries for Prices will be promptly dealt with on receipt of specifications. 4175

PRIESTMAN'S OIL ENGINE

GOLD MEDAL AWARDED, EDINBURGH, 1890.



Royal Agricultural Society's Silver Medal at Nottingham, 1888, and at Windsor, 1889.

(Priestman's and Humes' Patents).

USING COMMON MINERAL OILS ONLY.

SPECIALLY SUITABLE FOR ELECTRIC LIGHTING.

Printing, Pumping, Sawing, Threshing, Chaff Cutting, Corn Crushing, Driving Lathes, and Paint and other Mills, &c.

NO COAL. NO GAS. NO STEAM. NO BOILER.
NO SPARKS. NO SMOKE. NO DANGER.

No extra charge made for insurance.

FIRST PRIZE AWARDED FOR SMALL FARMER'S MOTOR, PLYMOUTH, 1890.

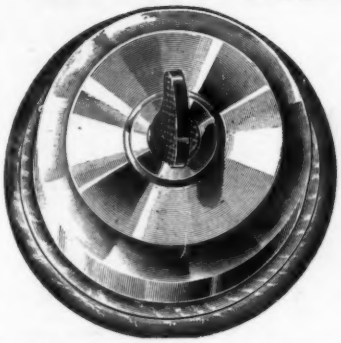
Priestman's Stand, Verandah B, outside Camperdown Gallery, Royal Naval Exhibition.

Fullest Particulars on application to— 3358

Works:—HULL. **PRIESTMAN Bros., Ltd.** London Office 73a, QUEEN VICTORIA ST., E.C.

THE PAISTE SWITCH.

Record: 100,000 in daily use.



The movement breaks and completes the circuit in an instantaneous manner, preventing arcing or charring of the contact parts. Mounted on China, with cover and handle of same material; also on Porcelain, with metal cover. Correspondence invited.

A. REYROLLE,

10. UNION MEWS, UNION STREET. MIDDLESEX HOSPITAL, LONDON, W. 3866

Offices:
98 & 100, QUEEN VICTORIA STREET, CITY.

Telegrams {"EXSICCANT LONDON." "DIELECTRIC MANCHESTER."

OKONITE
TRADE MARK

Works:
NEWTON HEATH, MANCHESTER.
and
PASSAIC, U.S.A.
Telephone 1,560.

THE INTERNATIONAL OKONITE CO., LTD.,

MANUFACTURERS OF EVERY DESCRIPTION OF

INSULATED WIRES AND CABLES,

OKONITE, VULCANISED RUBBER, GUTTA-PERCHA AND COMPOUND.

CONTRACTORS ON THE ADMIRALTY LIST.

Improved Laminated & Compound Strip for Dynamos.

SPECIALITIES IN FLEXIBLE CABLES AND CORDS.

THE Company's Factories at Passaic, U.S.A., and Newton Heath, Manchester, are the largest and most complete insulated wire works in existence, and the machinery employed is the result of many years' experience, both British and American. The Company are the actual manufacturers of the wires and cables mentioned in their Catalogue, which will be sent post free on application. Conductivity and insulation of every class listed are guaranteed.

CONTRACTORS FOR CENTRAL STATION INSTALLATIONS.

EUROPEAN AGENTS FOR

The NEW YORK BELTING & PACKING CO., Ltd.

MECHANICAL RUBBER GOODS OF EVERY DESCRIPTION. 4156

A. VAUGHAN-STEVENS, Managing Director.

BROMPTON ELECTRIC FITTINGS CO., LTD.,

148, BROMPTON ROAD. S.W.

MANUFACTURERS (UNDER PATENT) OF

CONNECTORS & ADAPTERS,

FOR USE WITH PORTABLE LAMPS WHERE WALL SOCKETS ARE NOT FIXED.

Manufactured to suit all the well-known makes of holders and plugs. A boon in bed-rooms lighted only by brackets. Write to Manager for samples and particulars.

SUPPLIERS OF ELECTRIC LIGHT FITTINGS FOR ALL PURPOSES.

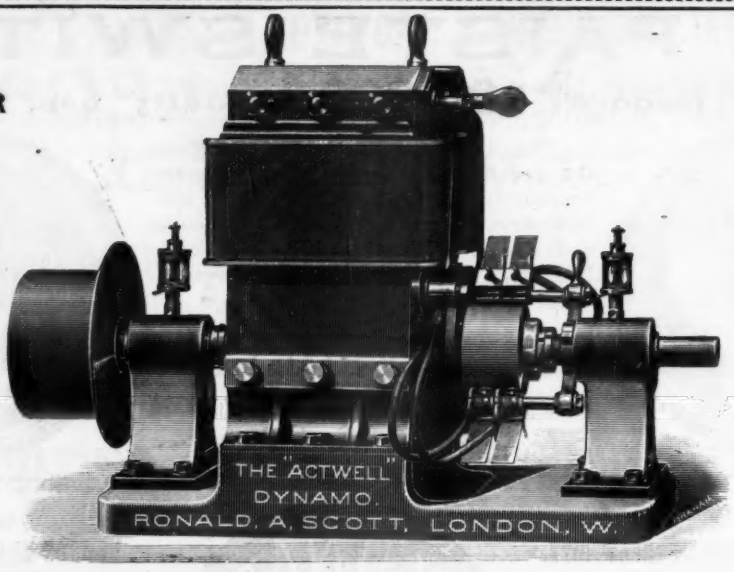
ESTIMATES GIVEN FOR INSTALLATION WORK WITH OR WITHOUT FITTINGS.

CATALOGUES AND PRICE LISTS ON APPLICATION. LIBERAL TERMS TO THE TRADE

BROMPTON ELECTRIC FITTINGS Co., Ld., 148, Brompton Rd., S.W. 4236

DYNAMOS FOR
LIGHTING,
PLATING,
DEPOSITING.

SEND FOR
ESTIMATES.



MOTORS FOR
PUMPING,
HAULING,
DRILLING, &c.

SEND FOR
ESTIMATES.

RONALD A. SCOTT, M.I.E.E.,

CONTRACTOR TO THE LORDS OF THE ADMIRALTY,
INDIAN GOVERNMENT, &c.,

ACTON HILL ELECTRICAL WORKS, LONDON, W.

24-inch Type Admiralty Projector

The ONLY Works in the Kingdom where COMPLETE SEARCH LIGHT OUTFITS for Naval or Suez Canal purposes can be obtained at a moment's notice.

Stand No. 15
Camperdown Gallery,
ROYAL NAVAL EXHIBITION,
May, 1891.

20-inch Admiralty Type Projector.

The Lords of the Admiralty have placed this year's contracts for Projectors and Hand-Feed Lamps with RONALD A. SCOTT.

3674

THE BIRMINGHAM TELEGRAPH FACTORY, LIMITED.

No. 11.] BIRMINGHAM, 26TH JUNE, 1891. [ILLUSTRATED SERIES.

MANUFACTURERS OF

Poles, Pole Chairs, Iron Standards, Stay Rods, Struts, Swivels, Spurs, Wall Plates, Channel Iron Arms, Oak Arms, Pole Clips, Pole Brackets, Angle Brackets, Chimney Brackets, Saddles, Roofs, Finials, Caps, Iron Hoods, Hoop Guards, Wire Guards, Lightning Points, Pole Steps, Angle Plates, Staples, Nails, Washers, Insulators, Shackles, Insulator Bolts, Cables, Wires, Leads, Printers, Sounders, Keys, Single Needles, Bright's Bells, "A B C" Instruments, Duplex and Quadruplex Apparatus, Telephone Magnetos, Transmitters, Receivers, Generators, Electric Bells, Indicators, Pushes, Burglar Alarms, Mining Gongs. Fire Station Switchboards, Street Pillars and Wall Boxes, Night Watch Tell-Tales and Thermostats. Batteries, Screws, Terminals, Cabinet Case Work, Testing Apparatus, Construction Tools, and every description of Apparatus connected with Telegraph, Telephone, and Electric Signal Engineering, &c.

NOTICE.—LONDON OFFICE.

WE beg to inform our numerous friends that we have opened a London office in

TEMPLE CHAMBERS, WHITEFRIARS,

where prices and full particulars of our manufactures may be obtained.

OUR NEW CATALOGUE.

In consequence of our having determined to make the Telephonic Section of our New Catalogue as comprehensive as possible, the publication has been very considerably delayed, and will not be completed for several weeks. Meanwhile, those who are desirous of having copies should apply to us at once. The price,

FIVE SHILLINGS,

is only to those who have no account with us; to our customers it is presented

GRATIS.

Telegraph Address: "INSULATOR, BIRMINGHAM."

Telephone, No. 4094.

Managing Director: **Mr. J. SLATER LEWIS.**

THE

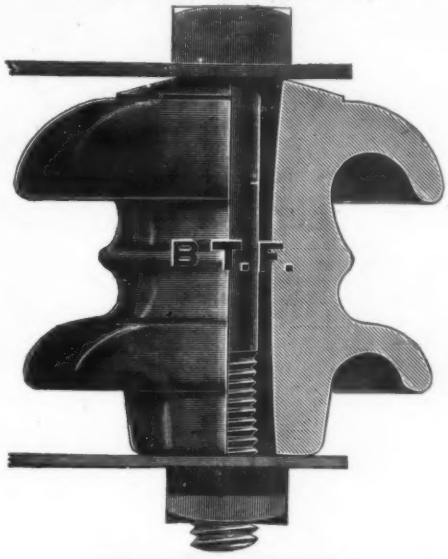
Birmingham Telegraph Factory,

LIMITED.

FRIDAY, 26TH JUNE, 1891.

"BRIGHT" SHACKLES.

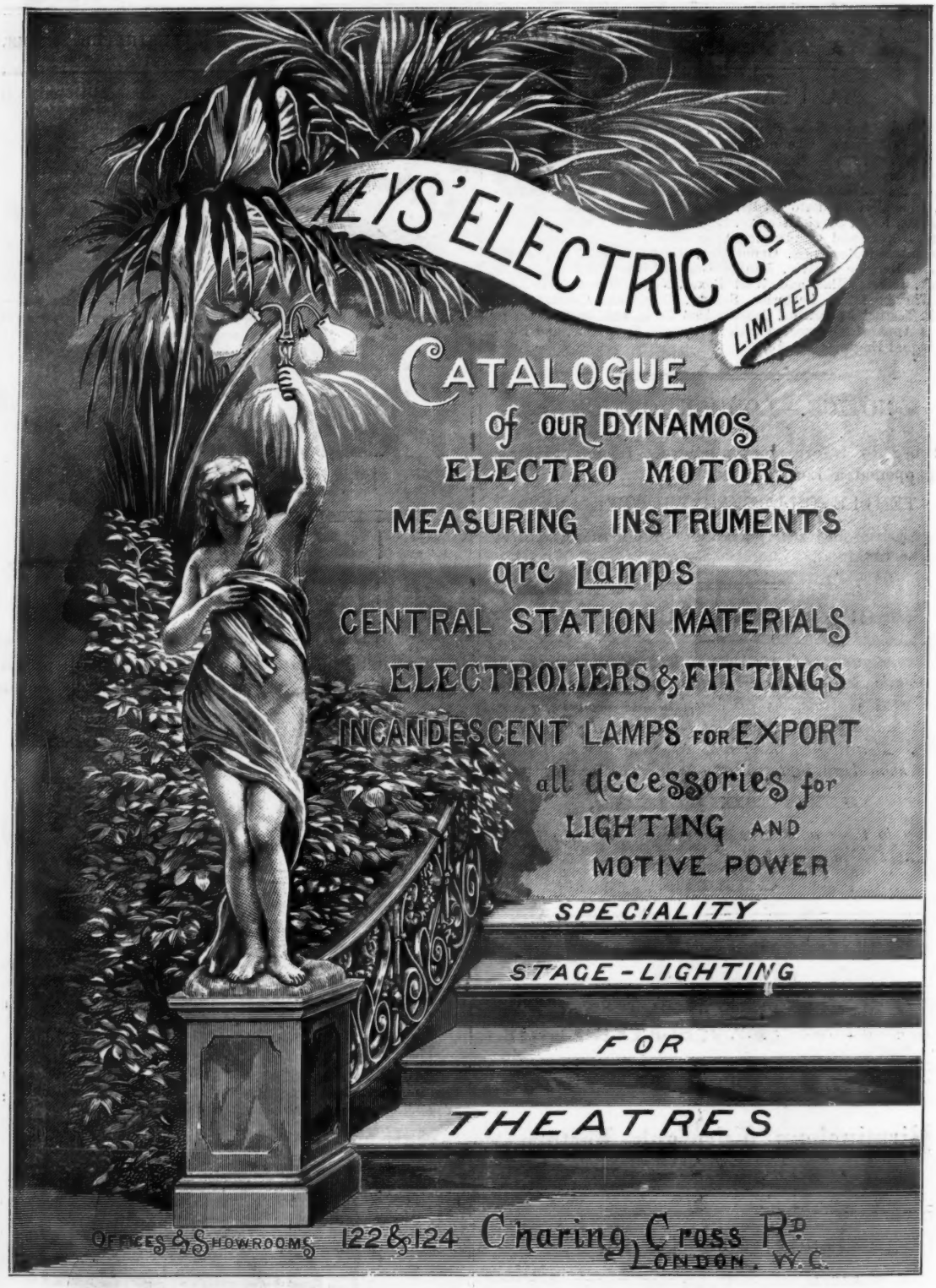
WE give this week an illustration of the standard pattern of "Bright" shackle. We make these insulators in three sizes, and in white or brown porcelain. The woodcut shows the shackle-bell fitted with bolt and straps. It will be understood that the straps are of the ordinary length, and are fitted with an additional bolt for securing them to the arm or other support.



DRAW-VICE AND KEY.

OUR second illustration shows the standard pattern draw-vice and key, as supplied by us to the leading companies and contractors. The drawing is half scale, and the vices can be supplied either in iron or steel.

CATALOGUE NOW READY.



ASK FOR COPIES.

NEW TELEPHONE No. 6770. Telegraph Address: "SECOHM, LONDON."

NALDER BROS. & Co.,

CONTRACTORS TO H.M. GOVERNMENT.

A LARGE SELECTION OF TESTING AND MEASURING INSTRUMENTS KEPT IN STOCK.

MANUFACTURERS OF

ELECTRICAL

TESTING INSTRUMENTS

FOR

LAND OR MARINE USE.

SWITCHBOARDS,

DISTRIBUTION BOARDS,

FUSE BOARDS.

AMMETERS

AND

VOLTMETERS.

P.O. Resistance Coils, with Bridge.

Improved Pattern Tripod Galvanometer.

P.O. Portable Galvanometer.

THESE INSTRUMENTS ALWAYS IN STOCK

16, RED LION STREET, CLERKENWELL

(Two Minutes' walk from Farringdon Street Station).

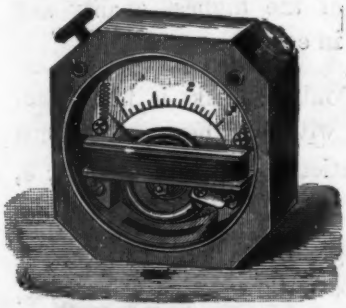
3556

HARTMANN & BRAUN'S

POCKET

VOLT-METER

FOR TESTING ACCUMULATORS.



TWO-THIRDS FULL SIZE.

SCALE TO 3 VOLTS, GRADUATED IN TENTHS.

O. BEREND & CO.,

61 FORE STREET, LONDON, E.C.

CURRENT-INDEX.

FOR INDICATING WHETHER ACCUMULATORS ARE CHARGING OR DISCHARGING.

ONE QUARTER FULL SIZE.

Fig. 379.

FREE TELEPHONES

EXPIRY OF "BELL" PATENT.

GENT & CO.,

FARADAY WORKS, LEICESTER,

Are making the most complete sets of Telephones in the market. Send for our new descriptive Price List, with instructions for fixing, Diagrams, and over 50 illustrations, FREE.

Fig. 374, including Bell, 21s. per set Fig. 379, including Microphone free of charge, on expiry of patent 31s. per set. A liberal discount to the trade.

INDICATORS, BELLS, PUSHES, BATTERIES.

The most varied Stock in the Trade.]

See our complete Pamphlet "How to fix Electric Bells, Telephones, Speaking Tubes, Lightning Conductors, &c.," 400 Illustrations and Diagrams, 90 pages, Post free, 4 stamps.

Fig. 374.

TELEPHONE No. 1887.

Telegrams:
"ELECTRICITY," London.
"INDUCTION," Manchester.
"APPARATUS," Glasgow.

G. BINSWANGER, *Managing Director.*

THE GENERAL ELECTRIC CO., LD.

(Of LONDON and MANCHESTER),

71, Queen Victoria Street,

London, E.C.,

June 26th, 1891.

LONDON: Head Offices, Show Rooms and Warehouse, 71, QUEEN VICTORIA ST.

MANCHESTER: Works and Offices, 45, Chapel St., SALFORD.

GLASGOW: Branch Office, 7, Bothwell Street.

MANUFACTURERS OF

ELECTRIC LIGHTING

PLANT AND MATERIAL,

ELECTRIC MOTORS,

ELECTRIC BELLS,

TELEPHONES,

ELECTRO-MEDICAL APPARATUS,

Electric Gas Lighters,

TELEGRAPH MATERIAL

&c., &c.

TO THE TRADE.

GENTLEMEN,—

We would specially call your attention to the very important improvements we have made in all our

CHINA ELECTRIC LIGHT FITTINGS.

We have reconstructed them so that they meet every possible requirement, among which may be mentioned standard sizes and great accuracy of bases, harder porcelain, perfect threads, and our **high insulation system of fitting metal parts.**

SWITCHES.

We now manufacture three kinds of Branch Switches; the brasswork and screws will be found of the highest quality and finish, and at the same time moderate in cost.

Our "QUEEN" SWITCH (Double Break) is fitted with **High Insulation** China Base, Cover with our new patent Dust Ring, loose handle and quick break action. Standard sizes 3, 5, 10, 15, and 25 ampères.

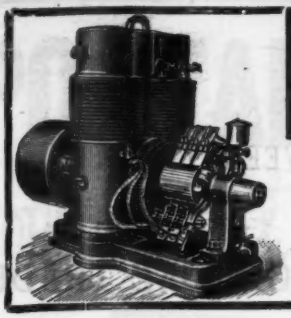
Our "BYNG" SWITCH (Single Break with Cut Out) is fitted with **High Insulation** China Base, Cover with Dust Ring, loose handle and quick break action. Standard sizes 3, 5, and 10 ampères.

Our "LINK" SWITCH is a high-class Switch fitted with **High Insulation** China Base, Fluted Brass Cover, link lever action and wedge contacts. This is our latest perfected Switch. Standard sizes 5, 10, 15 and 25 ampères.

The above are the various Branch Switches we now make, and we can confidently recommend them to your notice. Samples sent on application. Next week we will give you further information about our other fittings.

Yours respectfully,

THE GENERAL ELECTRIC CO., Ltd.



THE "CASTLE" SLOW SPEED.
HIGH EFFICIENCY.
J. H. HOLMES & CO.,
NEWCASTLE-ON-TYNE,
AND
17, COLEMAN STREET, LONDON, E.C.
DYNAMOS
2488

TO ELECTRICAL ENGINEERS & OTHERS.

SALE OF MACHINE TOOLS, PLANT & STOCK, &c.

WHEATLEY KIRK, PRICE & GOULTY

Are instructed to

SELL BY PUBLIC AUCTION

On the premises known as QUINTIN MATSYS FORGE, at 14, Griffin Street, York Road, Lambeth, London, S.E., early in July (unless previously disposed of by private treaty), the WHOLE of the CAPITAL MACHINE TOOLS, comprising:—Small Screw-Cutting and Self-Acting Lathes by Whitworth and Muir, Planing, Drilling, Shaping, and other machines. LOOSE PLANT and UTENSILS, 6-H.P. Nom. Vertical Engine and Boiler, Shafting, Stock of Ornamental wrought iron work for Electroliers and Architects' purposes. Office Furniture, Fittings, Stores and other effects.

Catalogues may be had shortly from WHEATLEY KIRK, PRICE AND GOULTY, 52, Queen Victoria Street, London, E.C.; and Albert Square, Manchester. 4113

In the High Court of Justice, Chancery Divison.—By Order of Mr. Justice Kekewich. Brunton v. the Electrical Engineering Corporation, Ltd., Alliance Engineering Works, West Drayton.

STOCK, PLANT AND MACHINERY.

MESSRS. HOBSON, RICHARDS & CO. will SELL by AUCTION, on the Premises, the Alliance Works, West, Drayton, close to West Drayton Station, G.W.R., on TUESDAY next, JUNE 30, 1891, and Following Days, at 12 o'clock precisely each day the complete and valuable STOCK, PLANT and MACHINERY of the ELECTRICAL ENGINEERING CORPORATION, LIMITED, including Steel Wire Rope and Cables, Carbon, Fuses, Mica, Sheet Fibre, and General Stores of Electrical Engineering, Engines, Boilers, double-bedded and other Planing Machines, Lathes; Drilling, Punching and Milling Machines; Dynamo Electric machines of various outputs, about 300 tons of Castings for engines and electrical machines, 5 tons of Special Magnet Iron, 10 tons of Copper Wire, quantity of Gun-metal and Brass Castings, Benches, Vices, Trolleys, Complete Foundry Plant, including Moulding Boxes, Ladles, Cupola, and 5-ton Jib Crane; also the valuable Designs and Patterns, and Office Furniture. Now on view.

Catalogues, upon receipt of 2 stamps, of FRANCIS W. PIXLEY, Esq. (Messrs. Pixley & Co.), the Receiver and Manager appointed by the Court, 24, Moorgate Street, E.C.; of Messrs. DOWSON, AINSLIE & MARTINEAU, solicitors, 28, Bedford Row, W.C.; and of Messrs. HOBSON, RICHARDS & Co., at the Auction Offices, 79, Coleman Street, London, E.C.

In the High Court of Justice, Chancery Division.—By Order of Mr. Justice Kekewich. Brunton v. The Electrical Engineering Corporation, Limited, 36, Albert Embankment.

SALE OF VALUABLE STOCK, PLANT AND MACHINERY.

MESSRS. HOBSON, RICHARDS & CO. will SELL by AUCTION, on the Premises, 36, Albert Embankment, Lambeth, on TUESDAY, JULY 14th, 1891, and Following Days, at 12 o'clock precisely each day, the very valuable PLANT, Machinery, Stock and Office Furniture of the ELECTRICAL ENGINEERING CORPORATION, LIMITED, including a 16-H.P. Engine by Ransomes, Driving Gear, Boiler, &c., Milling, Crushing, and Shaving Machines, 18 capital Lathes, Benches, Hand and Steam Presses, Wheel Cutting and Drilling Machines, Saw Benches, Vices, Pulleys, complete sets of Tools, Dynamos, Lamps, Switches, and every kind of Electric Light Fittings, Cables of various sizes, and a large quantity of raw material, the well-made office furniture and fittings.

May be viewed two days prior to sale, and Catalogues, when ready, obtained upon receipt of 2 stamps of FRANCIS W. PIXLEY, Esq. (Messrs. Pixley & Co.), the Receiver and Manager appointed by the Court, 24, Moorgate Street, E.C., of MESSRS. DOWSON, AINSLIE & MARTINEAU, Solicitors, 28, Bedford Row, W.C., and of the Auctioneers, MESSRS. HOBSON, RICHARDS & Co., 79, Coleman Street, London, E.C. 4112

TELEPHONE: 1788. TELEGRAMS: "INDICES," LONDON.
WHEATLEY KIRK, PRICE & GOULTY,
(Established 1855),
ELECTRICAL AUCTIONEERS, VALUERS AND ARBITRATORS,
52, QUEEN VICTORIA STREET, LONDON, E.C.,
And Albert Square, MANCHESTER. 1343

VULCANITE.
HARBURG INDIA-RUBBER COMB COMPANY.
London Warehouse: F. WINTER,
138, LONDON WALL WOOD STREET E.C.
EBONITE. 1710

CHEAP PREPAID ADVERTISEMENTS,

Relating to *Situations Vacant, Situations Wanted, Businesses Wanted, Businesses for Sale, Patents for Sale, Specific Articles of any kind Wanted, or for Sale or Exchange, are inserted at the rate of* ONE PENNY *Per Word (minimum* 1s.).

Three consecutive Insertions for the Price for Two.

*** This Scale does not apply to Trade Advertisements, terms for which can be had on application.

WANTED.—Canvasser for electric light work. Must be energetic and have some knowledge of fittings.—Apply, stating experience, to No. 4,492, ELECTRICAL REVIEW office. 4511

SALESMAN, Chandelier and Electric Light Fittings Trade. B. Verity & Sons require an additional Salesman. Must have had good experience in the best London houses.—Letter only, stating salary, age, and past experience, to 31, King Street, Covent Garden. 4502

A VACANCY occurs for Pupil in a firm of electrical engineers; exceptional opportunities for learning every branch, both practical and theoretical.—Apply No. 4,505, ELECTRICAL REVIEW Office. 4505

PUPILS.—An Electric Light Company in the South of Europe has vacancies for two Pupils with a small premium. The Engineer (English) can be seen by appointment until the 20th inst.—Address, H. M. S., care of M. C. Leite Rozas, Esq., 16, Philpot Lane, E.C. 4497

EXPERIENCED WIREMAN; take charge if required.—"P. A.," 42, Oxberry Avenue, Fulham, London. 4514

GRADUATE, with some electrical knowledge, and willing to pay a small premium, desires to get into a good firm where they set up installations.—Address, "C.," 65, Grafton Street. 4507

ENGINEER'S DRAUGHTSMAN (22) wants engagement, technical training, practical experience, understands dynamo calculations.—"H. D.," 2, Berkeley Crescent, Bristol. 4506

ELECTRICIAN (26) seeks engagement at home or abroad. Good knowledge of practical testing, accumulators. Good references.—Apply to 4,504, ELECTRICAL REVIEW Office. 4504

ELECTRIC Bell Fitter. Young man, thoroughly experienced, desires engagement.—Address, "BELL," 113, Morley Avenue, Wood Green. 4485

WANTED, employment as Assistant, by Electrical Engineer, age 19. Three years' practical experience, principally with an electric construction company. Highest references.—Apply to No. 4,494, ELECTRICAL REVIEW office. 4494

ELECTRICAL ENGINEER, age 25, requires engagement; considerable experience in dynamos, motors, traction, transmission of power and general electrical work.—Address "ALPHA," ELECTRICAL REVIEW Office. 4490

WANTED, engagement in electrical works or station, home or abroad. Have had electrical and commercial experience.—"A.I.E.E.," 37, Acre Lane, Brixton. 4491

[*Continued on next Page.*]

AS DRAUGHTSMAN.—"W. S.," 64, Bellenden Road, Peckham. 4490

ELECTRICAL Engineer seeks re-engagement; college certificate and several years' practical experience in electric lighting work, dynamo designing, &c.; good draughtsman.—Apply 4499, ELECTRICAL REVIEW, 22, Paternoster Row, London, E.C. 4499

FOR IMMEDIATE SALE—

40-H.P. (nominal) undertype Compound Engine capable of developing 120 I.H.P. All boiler fittings complete, with feed pump and injector; nearly new.

25-H.P. (nominal) undertype high-pressure double-cylinder engine. All boiler fittings, injector and feed pump.

12-H.P. (nominal) undertype high-pressure double-cylinder engine. Boiler fittings and feed pump.

Large quantity Dynamos, sizes up to 500 lights; Shafting, Standards, Belting. Number of Arc Lamps, best type.

Apply PILSEN ELECTRIC COMPANY, 4, Stanhope Street, Euston Road, London, N.W. 4509

WANTED, about 14 Accumulators, 31 Ls or equivalent capacity.—Lowest terms to CHAS. QUICKE, 429, Mansion House Chambers. 4510

FACTORY (lighted by electricity), with separate Offices and large Yard, TO BE LET, situated in an immediate suburb of London, unusually well lighted and admirably adapted for any light manufacturing business. Size of main building about 118 feet long by 35 feet wide. Three stories, basement, and every convenience. Boiler and engine power to the extent of 60 I.H.P. on the premises. Factory and machinery perfectly new, and available for immediate occupation.—For rent and other particulars apply to 4,508, ELECTRICAL REVIEW Office. 4508

ELECTRIC WORKS, ST. PANCRAS.

THE Vestry require the services of a competent Engineer and Electrician of good business experience, to act as General Manager of their Electric Works. Candidates must be between 25 and 45 years of age. Commencing salary will be £250 per annum. The appointment to be terminable by one month's notice by either party. Forms of applications and particulars as to duties may be obtained on application to the undersigned at the Vestry Hall.

Applications accompanied by not more than three testimonials of recent date, are to be sent in on or before MONDAY, the 6th, and Candidates are required to attend at 4 o'clock in the afternoon on THURSDAY, 9TH JULY, 1891.

By Order,

THOS. ECCLESTON GIBB, *Vestry Clerk.*

Vestry Hall, Pancras Road, N.W.,
24th June, 1891. 45'5

Mr. J. G. LORRAIN, M.I.E.E., M.I.M.E., &c.,
PATENT AGENT AND CONSULTING ENGINEER,
Norfolk House, Norfolk St., London, W.C.
"PATENTEE'S HANDBOOK" Post Free on Application. 4014

BOROUGH OF DOVER.

TO ELECTRIC LIGHTING COMPANIES AND OTHERS.

THE Corporation of Dover invite Tenders for the execution and maintenance of works needed for the supply of electricity within the Borough, in accordance with the Provisional Order granted by the Board of Trade to the Corporation.

Copies of the conditions can be obtained and the Provisional Order and deposited Plan inspected at my Office.

Tenders with a deposit of £5 (which will be returned in the case of each *bonâ fide* Tender) endorsed "Electric Lighting Tender" to be delivered at my office, not later than Friday, the 10th day of July next.

The Corporation do not engage to accept any Tender.

E. WOLLASTON KNOCKER, *Town Clerk.*

Town Clerk's Office, Dover,
18th June, 1891 4495

THE ELECTRIC & GENERAL INVESTMENT CO.,

LIMITED,

Offices:—1 & 2, GREAT WINCHESTER STREET, LONDON, E.C.

His Grace the DUKE OF MARLBOROUGH, Chairman.

The Company has been formed FOR THE PURPOSE OF FACILITATING THE PROMOTION AND DEVELOPMENT OF UNDERTAKINGS for Electric Lighting, Traction, Transmission of Power, and other industrial uses of electricity.

Communications may be addressed to—

J. CECIL BULL,
Secretary.

3427

VERITY'S WEEKLY LETTER.

TO THE ELECTRICAL TRADE.

RE INTRODUCING CLIENTS.

It frequently happens that a client cannot be prevailed upon to leave the selection of his electric fittings to the engineer who is carrying out his installation, nor will he always select from a catalogue.

In such cases as these we hope that the trade will send or bring their clients to us, resting assured that every attention will be paid them, and that the interests of the trade will be thoroughly protected. In all cases, however, where the client is not personally accompanied we shall be glad to receive notice of the client's probable call.

From the very large and varied stock that we are now enabled to keep we can confidently say that the client who cannot be suited at our show rooms must be indeed very hard to please, but if this should prove the case and something very special is required we are still in a position, by the aid of the most experienced draughtsmen and the best facilities for manufacture, to satisfy the most fastidious. Therefore, before you go to the trouble of getting designs, or otherwise losing valuable time, be sure that you send your client to see us, advising us at the time.

B. VERITY & SONS.

King Street, Covent Garden, and
137, Regent Street, London.

PORTABLE TESTING SET

(EVERSHED'S PATENT).

OHMMETER & MECHANICAL 100-VOLT GENERATOR.

Supplied to Principal Contracting and Supply Companies.

DIRECT READING,
FOR RAPID TESTING
WITHOUT CALCULATION.

W. T. GOOLDEN & CO. now have these instruments

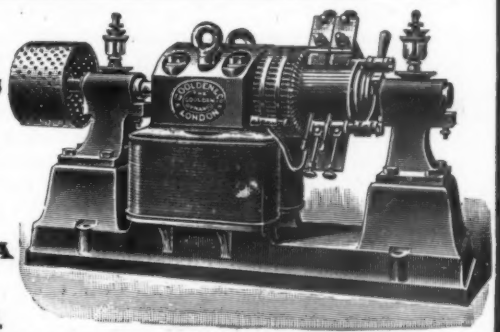
IN STOCK,

and regret the delay in delivery which the great demand for them has hitherto caused.

W. T. GOOLDEN & Co., WOODFIELD WORKS, HARROW ROAD, W.

GOOLDEN & Co.,

Contractors to English & Foreign Governments, Railways, Central Stations, &c.



DYNAMOS.

Splendid Mechanical Construction.

Armatures insulated entirely with MICA

Armatures and Field Coils VENTILATED INSIDE.

POSITIVE DRIVING of Conductors.

AMPLE CLEARANCE for Armatures.

Long Bearings. Clean and Economical Lubrication.

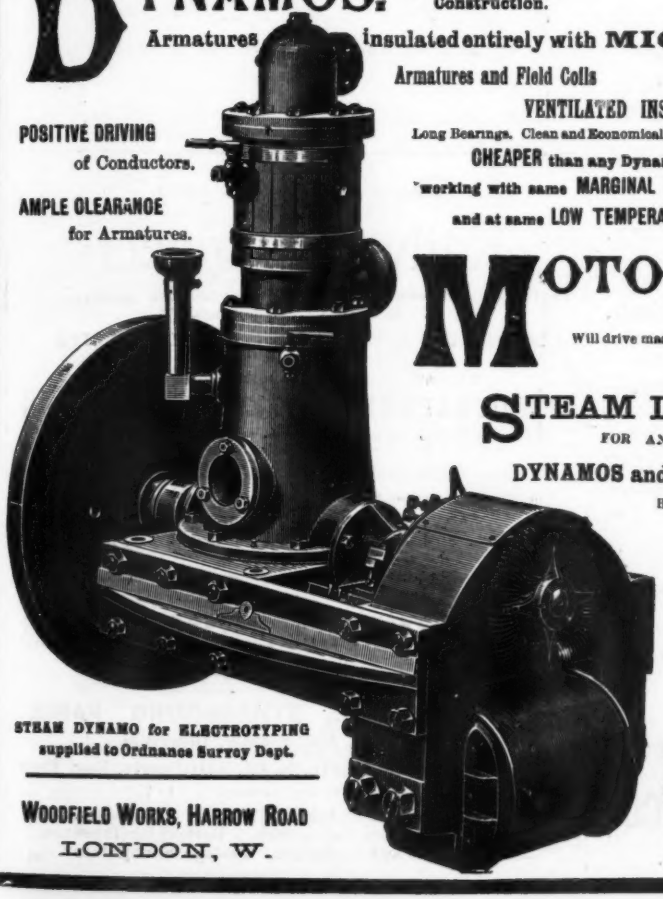
CHEAPER than any Dynamos working with same MARGINAL FACTORS and at same LOW TEMPERATURE.

Standard Goolden Overtype Dynamo, built with Gramme, Drum and Bar Armatures.

HAVE BEEN BUILT IN ALL SIZES,

Some weighing over SEVEN TONS without Engine

Dynamos of this type have worked at 350 volts, transmitting power in Mines (a severer test than lighting) for some years without a penny being spent in repairs.



MOTORS

STRONGLY BUILT.

Will drive machinery direct with Spur Gearing, without breaking down the armature.

HIGH EFFICIENCIES.

STEAM DYNAMOS

FOR ANY OUTPUT.

DYNAMOS and MOTORS

Built to Specification

STEAM DYNAMO for ELECTROTYPING supplied to Ordnance Survey Dept.

10 H.P. Launch Motor with Goolden Watertight Armature will work with Armature in water.

WOODFIELD WORKS, HARROW ROAD

LONDON, W.

Just Published, with 188 Illustrations, Crown 8vo, Cloth, 3s.

TELEPHONES:

THEIR CONSTRUCTION AND FITTING.

A practical treatise on the fitting up and maintenance of telephones and the auxiliary apparatus.

By F. C. ALLSOP,

Author of "Practical Electric Bell Fitting," "Electric Bell Construction."

London: E. & F. N. SPON, 125, Strand. New York: 12, Cortlandt St.

4473

THIS DAY, Crown 8vo, 368 Pages, with 113 Illustrations, 7s. 6d., Cloth.

DYNAMO CONSTRUCTION:

A PRACTICAL HANDBOOK for the use of Engineer-Constructors and Electricians-in-Charge. With examples of leading English, American and Continental Dynamos and Motors.

By J. W. URQUHART, Electrician.

Also by the same Author.

Fourth Edition, enlarged, 420 pages, with 157 Illustrations, Crown 8vo, 7s. 6d., Cloth.

ELECTRIC LIGHT, ITS PRODUCTION & USE.

By J. W. URQUHART.

"The whole ground of electric lighting is more or less covered and explained in a very clear and concise manner."—*Electrical Review.*

Just Published, Crown 8vo, 5s., Cloth.

ELECTRIC LIGHT FITTING:

A HANDBOOK FOR WORKING ELECTRICAL ENGINEERS.

By J. W. URQUHART.

"A really capital book, which we recommend to the notice of working electricians."—*Mechanical World.*

London: CROSBY LOCKWOOD & SON, 7, Stationers' Hall Court, E.C.

4488

Electric Railway of To-day, The.—By H. B. PRINDLE. Contents: The Electric Railway; Power Station; Electrical Apparatus; Switch Board; Line Construction; The Motor; Motor Truck; Overhead Construction; Curve Construction; Storage Batteries. Paper Covers, 2s. 6d., Post Free.

Magnetism & Electricity, Elementary Manual of. With numerous Illustrated Experiments and Examination Questions.—By ANDREW JAMIESON, M.Inst.C.E. Cloth, 3s. 6d., Post Free. Also Part I., 1s., Post Free; Part II., 1s. 6d. Paper Covers.

Practical Electrical Measurement.—By JAMES SWINBURNE. 55 Illustrations. Cloth, 4s. 6d., Post Free.

Incandescent Wiring Handbook.—By F. B. BADT. 41 Illustrations and 5 Tables. Cloth, 4s. 6d., Post Free.

Dynamo Tenders' Handbook.—By F. B. BADT. 70 Illustrations. Cloth, 4s. 6d., Post Free.

Bell Hangers' Handbook.—By F. B. BADT. 97 Illustrations. Cloth, 4s. 6d., Post Free.

Kirchoff's Laws and their Applications.—By E. C. RIMINGTON. Paper, 1s. 7d., Post Free.

Practical Electric Lighting.—By A. BROMLEY HOLMES, M.Inst.C.E. 4th Edition, with 89 Illustrations. Cloth, 3s. 6d., Post Free.

Electric Light Popularly Explained.—By A. BROMLEY HOLMES, M.Inst.C.E. 5th Edition, with 30 Illustrations. Cloth, 1s., Post Free.

Telephones; their Construction and Fitting.—By F. C. ALLSOP. Cloth, 5s., Post Free.

Any of the above Books can be had Carriage Paid by sending a remittance for the price indicated to

H. ALABASTER, GATEHOUSE & CO.,

22, PATERNOSTER ROW, LONDON.

THE COMPREHENSIVE INTERNATIONAL

WIRE TABLE.

Price 6s. 6d., post free 6s. 9d

Compiled and Published by W. S. BOULT, Assoc.M.Inst.C.E.,

60, CASTLE St., LIVERPOOL.

"We can cordially recommend this book as an indispensable addition to every practical electrician's library."—*Electrical Review.*

4163

THE

DAILY ORACLE

ESTABLISHED 1889.

Published Every Morning.

PRICE ONE PENNY.

AN INDEPENDENT FINANCIAL NEWSPAPER.

DEVOTED TO THE INTERESTS OF SHARE-HOLDERS AND INVESTORS.

IT CONTAINS:

FULL CRITICISMS ON NEW COMPANIES, MEETINGS, &c., LATEST PRICES OF QUOTED AND UNQUOTED SECURITIES, MINING, INSURANCE, PRODUCE & SPORTING NOTES, DAILY EXTRACTS FROM THE REGISTER OF BILLS OF SALE AND DEEDS OF ARRANGEMENT, SHIPPING INFORMATION.

Scale of Charges for Advertisements can be had on application.

AT ALL NEWSAGENTS AND BOOKSTALLS.

Offices: 20, BUCKLERSBURY, LONDON, E.C.

ESTABLISHED 1880.

THE Railway Engineer

An Illustrated Monthly Review of the Construction, Machinery and Administration of Railways.

MONTHLY, ONE SHILLING.

A Valuable Work for Reference, illustrated with large

LITHOGRAPHED WORKING DRAWINGS

Of Locomotives and other Rolling Stock; Bridges and all kinds of Railway Appliances.

ANNUAL SUBSCRIPTIONS, IN POSTAL UNION, 14s.

(Payable in Advance, including Postage.) Specimen Copy Post Free, 1s.

OFFICES:—8, CATHERINE ST., STRAND, LONDON, W.C.

Le MONITEUR des INVENTIONS INDUSTRIELLES

15th YEAR.

6 BOULEVARD DE STRASBOURG PARIS.

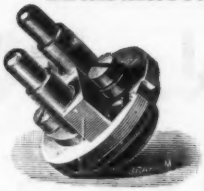
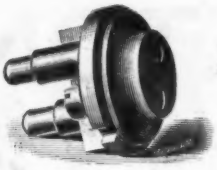
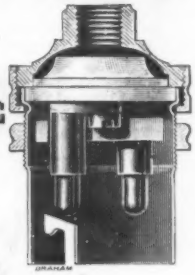
Sixteen Pages, Half-Monthly, Illustrated.

SUBSCRIPTION: 6s. Yearly, 3s. 6d. Half-Yearly, Post Free

Contains the Catalogue of French Patents. Details gratis the New Inventions of its Subscribers. Review for Inventors, Manufacturers and Capitalists. Postage Stamps taken. 103

POOLE & WHITE'S **PATENT** "B.C." LAMPHOLDERS.

Manufactured under

SPECIAL   LICENSE 

from the

Edison & Swan United Electric Light Co., Ltd.,

POOLE & WHITE, Ltd.,

ELECTRICAL and MECHANICAL MANUFACTURERS & SUPPLIERS

Works, Show Rooms and Offices:

58 & 59, BREAD ST.,

CHEAPSIDE, LONDON, E.C.

Telegraphic Address:

"PLATESSA," LONDON.

Telephone No.

1982.

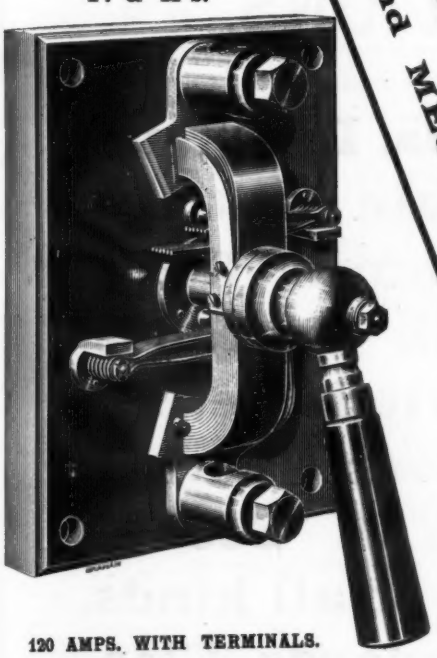
SPECIAL TERMS for EXPORT.

ENGINEERS,

Wholesale ONLY.

MAIN SWITCHES.

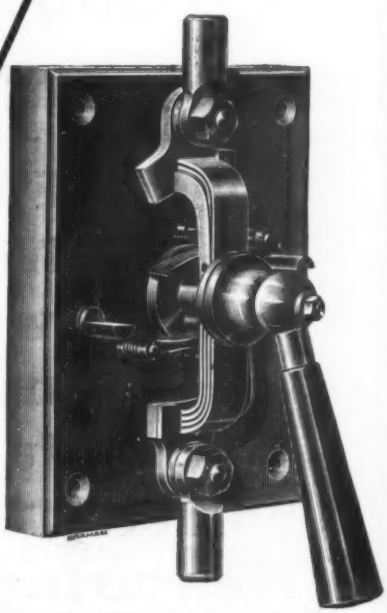
"NEW DIAMOND" P. & W's.



120 AMPS. WITH TERMINALS.

SPECIALITY SWITCH-BOARDS.

SWITCHES (PATENT)

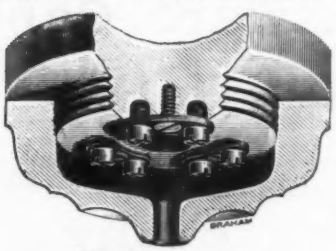


70 AMPS. WITH CABLE CONNECTORS.

STANDARD CEILING ROSE.

NEW DIAMOND SWITCHES, PLAIN, OR

SIZES FROM 3 to 1,000 AMPERES.



2½", 3", 3½" diameter.

PORCELAIN.

POOLE & WHITE'S PATENT

CREAM, BLACK.

DECORATIONS TO DESIGN.

PRICE LISTS SENT POST FREE ON APPLICATION.

SEND AT ONCE TO

APPLETON, BURBEY

AND

WILLIAMSON,

BALMORAL BUILDINGS, 91, QUEEN VICTORIA STREET,

LONDON, E.C.,

for their latest

CATALOGUE & PRICE LIST.

over

300 ILLUSTRATIONS.

PART I.—Switchboards, Distributing and Fuse Boards, Main Switches to carry from 20 to 4,000 amps., Regulating Switches, Branch Switches, the Patent "Nipper" Switch, Ceiling Roses, Fuses, Edison-Swan Lampholders, the Patent Wall Socket, Measuring Instruments of all kinds, Fittings, Brackets, Standards, Electroliers, Glassware, Cables & Casing.

PART II.—Bells, Indicators, Pushes, &c.

FACTORY:

TOWER BRIDGE ELECTRICAL WORKS, HORSELYDOWN,

LONDON, S.E.

4293

The INTERNATIONAL ELECTRIC CO.

Sole Depôt of MIX & GENEST,

LONDON: 34, ALDERMANBURY, E.C.

Before Ordering **TELEPHONES** Elsewhere,

WRITE FOR OUR PRICE LIST.

Our Instruments are specially constructed for the reception of the **MICROPHONE** (M. & G. Patent) which we shall supply **FREE OF CHARGE** upon the expiry of the Edison Patent.

THOUSANDS SOLD. UNIVERSALLY APPROVED.

ALL ELECTRIC SUPPLIES.

THE WEYMERSCH ELECTRIC BATTERY SYNDICATE, LIMITED.

[Ed. C. de Segundo, Assoc.M.Inst.C.E., *Executive Engineer.*] CAPITAL-£20,000. [Ch. F. Jones, *Secretary.*]

Offices: 2, VICTORIA MANSIONS, 28, VICTORIA ST., S.W. Works: Colwell Road, EAST DULWICH, S.E.

THE ADVANTAGES OF THE WEYMERSCH PRIMARY BATTERY ARE AS FOLLOWS:

Absolute safety in working.
Extreme simplicity of manipulation.
No risk of fire or explosion.

No attention required for from 12 to 30 hours.
No skilled attention or technical knowledge necessary.
No smoke; No noise.

Can be used in places where no other means of producing mechanical power could be employed.

The Battery is suitable for—
ELECTRIC LIGHT, ELECTRIC LAUNCHES, ELECTRO-PLATING, SMALL PUMPS, MINER'S LAMPS, VENTILATING FANS, SMALL LATHES, SEWING MACHINES, DENTAL MOTORS, &c., &c.

This battery is at present successfully working one of the Blackman Co.'s Electric Motor Fans for ventilating, and is being used for driving an electromotor in an electric launch, and for several installations for electric light in private houses.
All information as to price and other details can be obtained at the Offices of the Syndicate, 2, Victoria Mansions, 28, Victoria Street, S.W., where the Battery can be seen at work every day.

THE "CAMPBELL" GAS ENGINE

[TELEPHONE No. 92.] SOLE MAKERS: [Telegraphic Address: "CAMGAS, HALIFAX."]

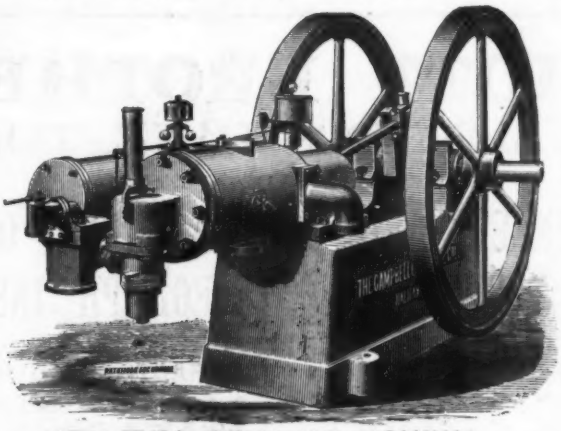
THE CAMPBELL GAS ENGINE CO., LTD.,

Works & Head Offices:—HALIFAX, ENGLAND.

LONDON: 114, Tooley St., S.E. GLASGOW: 111, West George St.

Used both at HOME AND ABROAD for ELECTRIC LIGHTING.

HIGH-CLASS WORKMANSHIP.



ECONOMY.

REGULARITY.

SIMPLICITY.

NEW TYPE OF 12 H.P. NOMINAL. 4127

SPECIALLY ADAPTED FOR ELECTRIC LIGHTING.

WESTERN ELECTRIC CO.,

MANUFACTURERS OF

TELEPHONES.

WHOLESALE ORDERS ONLY

79, COLEMAN STREET, LONDON, E.C.

CHICAGO, NEW YORK AND ANTWERP.

1906

— A —

GOOD MOTIVE

POWER is necessary in every business, and all who have tried Electricity in working Trams, Cranes, Hoists, Launches, and all kinds of Machinery, acknowledge it to be far before any other. In many cases heavy insurances have been reduced, and considerable savings effected. Wherever means exist for generating the current (which can be used for lighting as well as power) estimates should be applied for, and the claims of Electricity considered. OUR MOTORS are in use in most important places for the above purposes, and are pumping many thousands of gallons of water per hour from mines throughout the country.

FULL PARTICULARS ON APPLICATION.

CROMPTON & CO., Ltd., Mansion House Buildings, LONDON, E.C.
Works: LONDON and CHELMSFORD.

311

ELLIOTT BROTHERS,

101 & 102, ST. MARTIN'S LANE, LONDON, W.C.

(ESTABLISHED 1800).

ELECTRICAL ENGINEERS AND MANUFACTURERS OF ALL KINDS OF ELECTRICAL TESTING AND TELEGRAPH INSTRUMENTS.

SUBMARINE MINING APPARATUS, &c. CONTRACTORS TO H.M. GOVERNMENT.

Highest Award Paris Exhibition 1889. Only "Grand Prix" to any English Electrical Exhibit.

Telegraph Address: "OHM," LONDON. Telephone No. 3852.

310

WOODHOUSE & RAWSON UNITED, LTD.,

INDICATORS IN SOLID MAHOGANY OR OAK CASES,

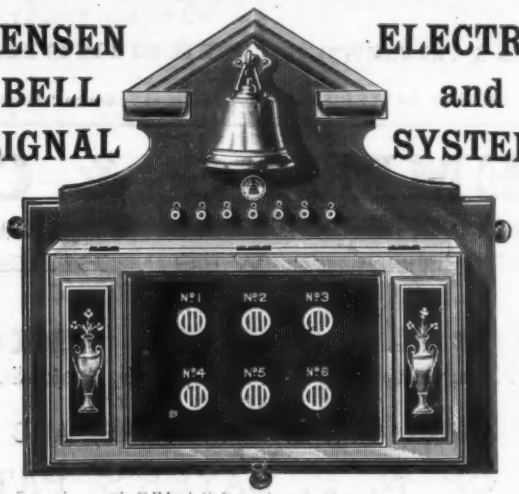
WARRANTED NOT TO WARP.

MARVELS OF SIMPLICITY!!

The most perfect and simple indicators yet invented. Never fail. No permanent magnet or other delicate complication likely to get out of order.

FOR
TELEGRAPH,
TELEPHONE,
RAILWAY,
MINES,
SHIPS,
FIRE,
BURGLAR,
FROST,
And all kinds of
SIGNALLING
AND
ALARMS.

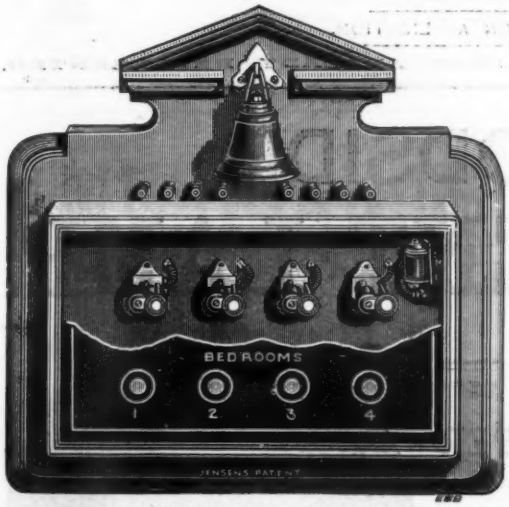
JENSEN BELL SIGNAL ELECTRIC and SYSTEM.



FOR
MANSIONS,
HOTELS,
BANKS,
SHOPS,
OFFICES,
FACTORIES,
SCHOOLS,
COLLEGES,
CHURCHES,
CHAPELS,
And all kinds of
BUILDINGS.

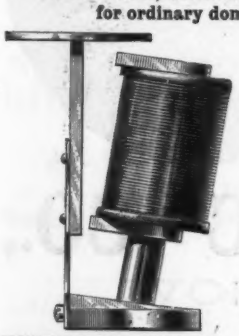
SPEAKING TUBES.

THE "VIBRATE COMPACTUM," a Self-replacing Indicator fitted with Two Dry Cells, connected up ready for use. All that required is to fix the line wire to the terminals. An ideal Indicator for export.

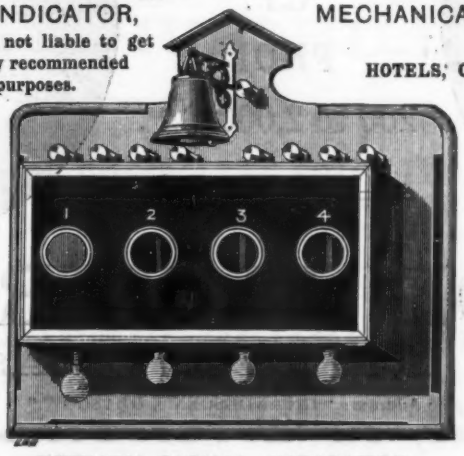


THE VIBRATING INDICATOR,
Requiring no replacement, and not liable to get out of order, can be strongly recommended for ordinary domestic purposes.

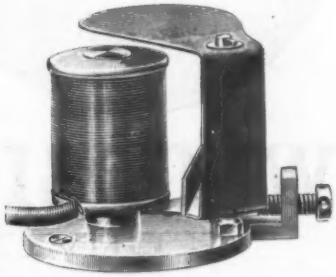
MECHANICAL REPLACEMENT INDICATOR
Suitable for HOTELS, CLUBS, and PUBLIC INSTITUTIONS.



MOVEMENT OF VIBRATING INDICATOR.



RETURN SIGNAL INDICATOR.



MOVEMENT OF MECHANICAL REPLACEMENT INDICATOR.

88, QUEEN VICTORIA ST., LONDON, E.C.

JAMES PITKIN,

Philosophical and Electrical Instrument Maker,

56, RED LION ST., CLERKENWELL, LONDON, E.C.

SPECIALITIES:

Capt. HOLDEN'S Electric Chronographs, Volt and Ampère Meters, Reflecting Galvanometers, Locking and Firing Keys, Hydrometers.

PITKIN'S Electric Hand Lamps for Gunpowder Mills, Coal Mines, Gas Works, &c.

PITKIN & NIBLETT'S Explosive Gas Detecting, Recording, and Electric Alarm Instruments.

GARRETT'S MAGNETO BELLS & TRANSMITTERS.

IMPROVED PRIMARY AND SECONDARY BATTERIES. 4195

ESTABLISHED 1830.

ENGINEERS' CASTINGS

BRASS, GUN METAL,

PHOSPHOR BRONZE

CASTINGS AND INGOTS,

PHOSPHOR TIN,

"ALBION" BRAND,

BABBITT'S METAL,

&c. &c

J. & J. HUGHES,

ALBION METAL WORKS,

WOODCOCK STREET,

BIRMINGHAM.

Telegrams "Bronze," Birmingham. 3884

T. L. HEMMING & CO., Ltd.,

Electrical and General Engineers,

NEW JOHN STREET WEST, BIRMINGHAM.

MANUFACTURERS OF

DYNAMOS AND MOTORS,

For Electric Lighting, Electro-Plating, Electro-Typing, Copper Refining, Charging Storage Cells, Transmission of Power, &c.

(TO THE TRADE ONLY).

VOLT METERS, AMPERE METERS, ARC LAMPS,

ALSO

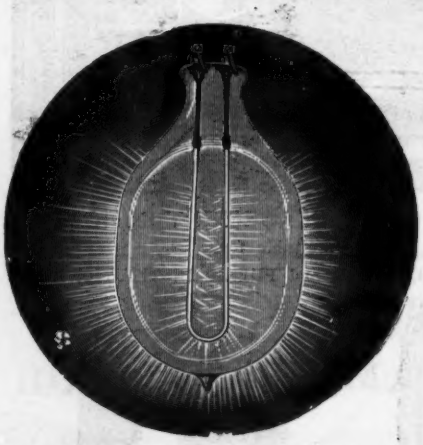
SOLE MAKERS OF W. B. SAYER'S PATENT DYNAMO.

The only machine in the market giving off various pressures at the same time in different directions, consequently the only perfect plating dynamo yet made.

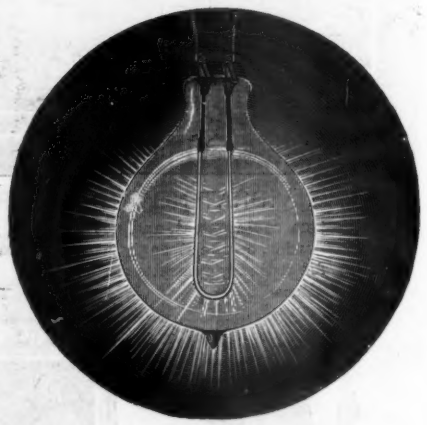
ILLUSTRATED PRICE LISTS ON APPLICATION.

AGENTS REQUIRED IN TOWNS WHERE NOT ALREADY REPRESENTED. 4449

THE WOODSIDE INCANDESCENT LAMP.



2 WATTS PER C.P. FROM 200 to 2,000 C.P.



WOODSIDE ELECTRIC CO.,

KELVIN BRIDGE, GLASGOW.

Telegraphic Address: "INCANDESCENT, GLASGOW."

PRICES ON APPLICATION.

These Lamps were used for Lighting Grand Concert Hall, &c., Edinburgh Electrical Exhibition. 4104

GÜLCHER ELECTRIC LIGHT & POWER COMPANY, LTD.

ARE NOW MANUFACTURING SPECIALLY FOR THE TRADE.

BATTERSEA DYNAMOS.

300 Lights, £175
400 „ £220
500 „ £265
650 „ £320

TRANSFORMERS
BATTERSEA DYNAMO
ARC LAMPS AND ELECTRICAL APPARATUS
BATTERSEA MOTOR
THE GULCHER ELECTRIC LIGHT & POWER Co. LIM
BATTERSEA FOUNDRY LONDON S.W

BATTERSEA MOTORS.

25 H.P. £175
33 H.P. £220
40 H.P. £265
55 H.P. £320

3131

For Catalogue and Particulars apply to THE MANAGER, BATTERSEA FOUNDRY, S.W.

JOSEPH BOURNE & SON,

MANUFACTURERS OF THE WELL-KNOWN

STONEWARE TELEGRAPHIC INSULATORS AND BATTERY JARS.

For Thirty years these manufactures have been celebrated for a high degree of vitrefaction combined with great toughness and strength.

Brown Stoneware. White Stoneware. Brown Porcelain. Porous Cells.

Economy Strength and Durability combined. *Prize Medal, Paris Electrical Exhibition.*

Special Shapes for Telephone and Electric Lighting Wires.

Works: DENBY POTTERY, NEAR DERBY.

London Office: NEW ST. PANCRAS STATION EUSTON ROAD, N.W. 3097

RAMSDEN, CAMM & CO..

BRIGHOUSE. YORKSHIRE,

Iron and Steel Wire Drawers and Galvanizers.

MANUFACTURERS OF

TELEGRAPH, TELEPHONE AND CABLE WIRE,

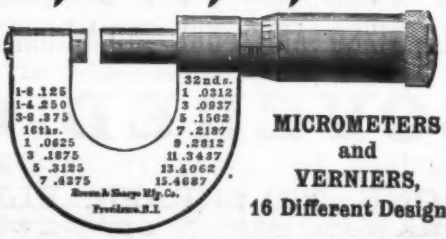
Contractors to H.M. Postmaster-General, the Indian and Colonial Governments and leading Railway Companies

SPECIALITIES:—FINE SIZES OF H.C. COPPER, GERMAN SILVER, &c., WIRES. 3069

IMPORTERS OF FINE AND ACCURATE

AMERICAN MACHINERY & TOOLS

QUICK SPEED SENSITIVE DRILLING MACHINES WITH ONE OR MORE SPINDLES. ALSO HEAVY POWER DRILLS.



MICROMETERS and VERNIERS, 16 Different Designs.

SEND 1s. FOR ILLUSTRATED CATALOGUE.

MILLING MACHINES, LATHES, &c.

FINE TOOLS IN GREAT VARIETY.

CHARLES CHURCHILL & CO., Ltd.,

21, CROSS STREET, FINSBURY, LONDON. 3040

CALLENDER'S BITUMEN TELEGRAPH & WATERPROOF Co.,

LIMITED.

101, Leadenhall Street, LONDON. Telegrams: "CALLENDER, LONDON." Telephone, No. 4,485.

Oldham Place, Renshaw Street, LIVERPOOL, and Cannon Passage, BIRMINGHAM.

Works: ERITH, KENT. Telegrams: "CALLENDER, PICARDY." Telephone, 8,411.

UNDERGROUND MAINS

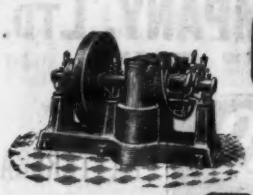
LAID COMPLETE ON CALLENDER-WEBBER OR SOLID BITUMEN SYSTEMS.

LEAD SHEATHED WIRES AND CABLES

FOR UNDERGROUND WORK, HOUSE AND FACTORY MAINS AND SHIP WORK.

Concentric Cables—ARMOURED—Metal Sheathed.

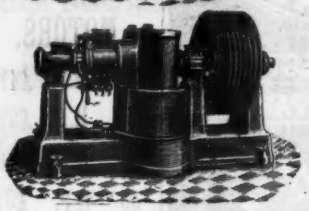
AERIAL CABLES. 1288

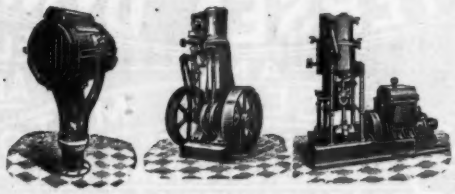


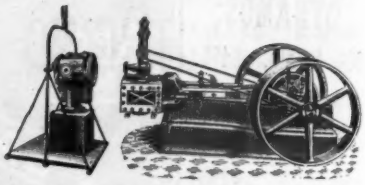
CHARLESWORTH, HALL & Co.,

RICHMOND HILL IRON WORKS,

MAKERS,







AGENTS:
EWEN & CO., 37, Walbrook, E.C
MORRISON & HARPER,
135, Buchanan Street, Glasgow.

OLDHAM.

COMPLETE INSTALLATIONS OF ALL KINDS.
Estimates on Application.
Telegrams "CHARLESWORTH, ENGINEERS."
Telephone No. 63, OLDHAM.

GEORGE EDWARD & CO.,

HERCULES IRON WORKS, JOHNSTONE, near GLASGOW.

PATENTEES AND MAKERS OF

PATENT VERTICAL HYDRAULIC MULTIPLE LEAD PIPE PRESSES,
For Covering Telegraph, Telephone and other Cables with Lead, and for Making Lead and other Metal Pipes, all in Long Lengths

PATENT HORIZONTAL HYDRAULIC MULTIPLE LEAD PIPE PRESSES,
For Making Lead and other Metal Pipes, Bends, and Traps, and for Covering Telegraph, Telephone, and other Cables with Lead in Long Lengths.

PATENT IMPROVED HYDRAULIC LEAD PIPE PRESSES,
As supplied to all the leading Pipe Makers in Great Britain, and abroad. For Making Solid Block Tin, and Block Tin Composition Tubes, Solid Block Tin Lined Lead Pipe, Solid Cold Pressed Lead Pipe, Lead Composition and Tinned Composition Pipes, Lead Rods for Bullets, Window Leads for Glass, Square, Hexagon and other shaped Pipes and Rods in Long Lengths.

IMPROVED SHEET LEAD ROLLING MILLS,
With Reversing Steam Engines or Reversing Gearing fitted with Self-Acting arrangements for Feeding the Lead Block and Sheets to Main Rolls, Double Power Geared Guillotine for Shearing the Rolled Plates up to 1¼ inches thick, Self-Acting Circular Cutters for Trimming Edges of Sheets and combining all our latest improvements for reducing labour and producing superior Milled Sheets.

ROLLING MILLS AND PIPE PRESSES CAN BE ALTERED TO OUR PATENT AND IMPROVED SYSTEM. 4296

THE FOWLER-WARING CABLES Co., LTD.,

32, VICTORIA STREET, LONDON, S.W.,

ALL CLASSES OF VULCANIZED AND PURE INDIA-RUBBER WIRES AND CABLES,

Sole Manufacturers of

LEAD-COVERED CABLES,

UNDER THE COMPANY'S PATENTS,

FOR TELEPHONE, TELEGRAPH, ELECTRIC LIGHT,

TRANSMISSION OF POWER,

And Underground Installations of every kind.

SPECIAL ANTI-INDUCTION TELEPHONE CABLES.

UNAFFECTED BY HEAT,
MECHANICAL STRENGTH
HIGH INSULATION,
LOW CAPACITY.

64-Wire Anti-Induction Telephone.

STEAM SHIPS, DOCKS,
CHEMICAL WORKS
FACTORIES, MINES,
DAMP PLACES, &c.

GOLD MEDAL.

PARIS EXHIBITION.

REFERENCES AND PARTICULARS ON APPLICATION. 3800

Works: NORTH WOOLWICH, E.

THE ACME ELECTRIC WORKS

Telephone No. 7,629. (FRANCIS TEAGUE, Manager), Telegrams: "SOUNDER, LONDON."

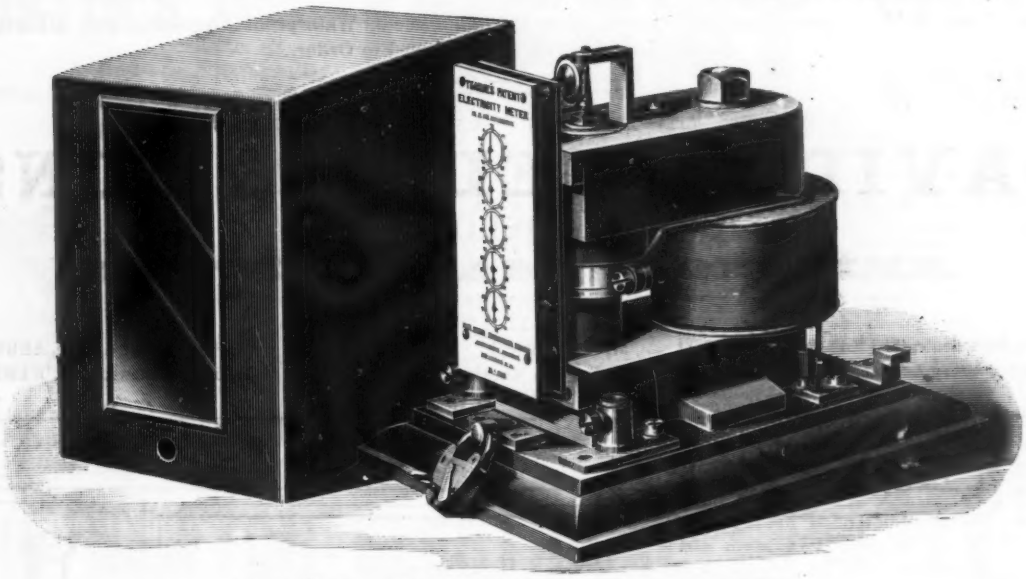
MANUFACTURING ELECTRIC & TELEGRAPH ENGINEERS,

Contractors to H.M. War Office, Admiralty, G.P.O., London County Council, &c.

MANUFACTURERS OF

TEAGUE'S PATENT ELECTRICITY METER,

Direct Reading in B.T. Units. No Constants or Multiplier required.

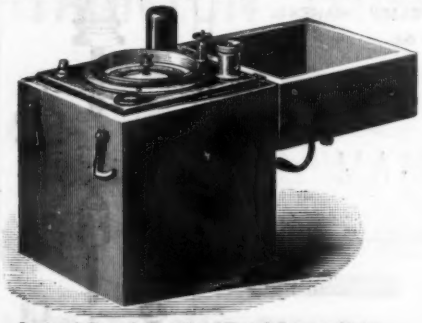


ALSO MAKERS OF THE

NEW COMBINED AYRTON & PERRY MAGNIFYING SPRING VOLT AND AMPERE METERS

(Made to read up to 1,000 Volts and 1,000 Amperes).

AYRTON & PERRY'S NEW PATENT TWISTED STRIP AMPERE & VOLT METERS



Ayrton & Perry's Combined Volt & Ampere Meter, reading on one dial with one pointer.

EACH INSTRUMENT IS TESTED BY THE INVENTORS AND BEARS THEIR CERTIFICATE OF ACCURACY.

Spring Ammeter, Direct Reading.

Cockburn's Patent Quick Break Lock Switches, Main Switchboards.
Cockburn's Patent Cut-Outs and Reliable Safety Fuses.

ELECTRICAL ACCESSORIES.

Works & Offices: FERDINAND STREET, CHALK FARM, N.W.

INSULATING PRODUCTS.

VULCANITE & EBONITE.
CELLUVERT FIBRE.

SHEET, RODS, OR TUBES. SPECIAL REQUIREMENTS MADE TO ORDER.

VULCANITE CELLS AND PATENTED SEPARATORS FOR SECONDARY BATTERIES.

Pure Para Telegraph Strip, Insulating Tape, &c. Patented Non-Stretching Pure Rubber Insulating Tape. Rubber Goods of all kinds for Electrical Purposes.

PATENT COTTON "SIMPLEX" BELTING

For DYNAMO, MAIN, and OTHER DRIVING.

Valves, Sheet Rubber, Hose Pipes, Fire Hose, Chemical Appliances, Waterproof Garments, and all kinds of India-Rubber Goods in Stock, and to Order.

PRICE LISTS ON APPLICATION TO

DAVID MOSELEY & SONS,

CHAPEL FIELD WORKS,

ARDWICK, MANCHESTER.

WAREHOUSES:

2, 4, & 6, New Brown St., MANCHESTER.
14, Aldermanbury Avenue, LONDON, E.C.
57, Miller Street, GLASGOW.
20, Rue des Marais, PARIS.
14, Place Sainte Gudule, BRUSSELS.
29, Ki Reichenstrasse, HAMBURG.

3490

ESTABLISHED 1840.

A. STOKES & CO.,

MANUFACTURERS BY PATENT MACHINERY OF

Machine Screws, Studs, & Small Turned Parts,

For TELEGRAPH ENGINEERS, OPTICIANS, MATHEMATICAL, SURGICAL, MUSICAL INSTRUMENT, TRUSS and CHANDELIER MAKERS, STATIONERS, SUNDRYMEN, &c., &c.

BRASS AND COPPER SCREW WORKS.

GREEN STREET,

DERITEND, BIRMINGHAM.

ESTIMATES GIVEN TO PATTERNS.

NOTICE.

NEW ADDRESS:

RANKIN KENNEDY, Carntyne Electric Works, SHETTLESTON, GLASGOW.

RANKIN KENNEDY was the first Dynamo Maker in Scotland, commencing to manufacture them in 1881; two were exhibited at the Crystal Palace, London, in that year. These Dynamos are now the most perfect in design and construction, great numbers are in use. Special terms to contractors. Engines and Dynamos combined or separate. Alternating current motors made for any circuit with or without Commutators, the only good alternating motors in the market. High power incandescent lamps very cheap. 4309

G. P. WALL,

MAGNETO WORKS, SHEFFIELD.

SPECIALITIES of STEEL and STEEL WIRE adapted to the INSTRUMENT and ELECTRICAL TRADES.

MAGNET STEEL of the highest efficiency.

SWEDISH IRON, ABSOLUTELY PURE AND DIAMAGNETIC.

TOOL STEELS—ALL DESCRIPTIONS.

COLD ROLLED STEEL in all dimensions. COLD ROLLED STEEL tempered and polished in strips.

SPRINGS, HELICAL, SPIRAL, OR TO PATTERNS.

Best Round Steel Wire Polished in Lengths or Coils, all gauges. Tempered Wire, Polished and Plated Music Wire, Qualities for Springs, &c. 4319

AUSTIN'S "INFANT" DYNAMOS AND MOTORS.

No. 4.

Specially designed to meet the requirements of Electric Light Engineers. For Arc or Incandescent Lighting, Direct; Charging Accumulators; Transmission of Power; Electrolysis in all its branches, &c., &c.

50, 100, 200, 400, 700 and 1,000 WATTS.

HAND-POWER DYNAMOS.
CONTINUOUS CURRENT TRANSFORMERS.
MULTIPOLAR MOTORS
(FOR SLOW SPEED).

AGENTS.

LONDON:	Paterson & Cooper.
IRELAND:	The United Electrical Engineering Co. of Ireland, Limited, Dublin.
FRANCE:	E. H. Cadiot, Paris.
ITALY:	Prospero, Peyran, Turin.
RUSSIA:	Alphonse, Schtchawinsky, St. Petersburg.

Price Lists and Particulars Free on application. 418

AUSTIN & MYERS, Florence Electrical Works, ARMLEY, LEEDS

THE NEWTON ELECTRICAL ENGINEERING WORKS, TAUNTON.

THE

"TAUNTON" DYNAMOS

AND

MOTORS.

Highest Efficiency; Beauty of Design; Moderate Speeds; Best Workmanship and Materials.

NEWTON & HAWKINS'

PATENT

AUTOMATIC SWITCHES.

NEWTON ARC LAMPS.

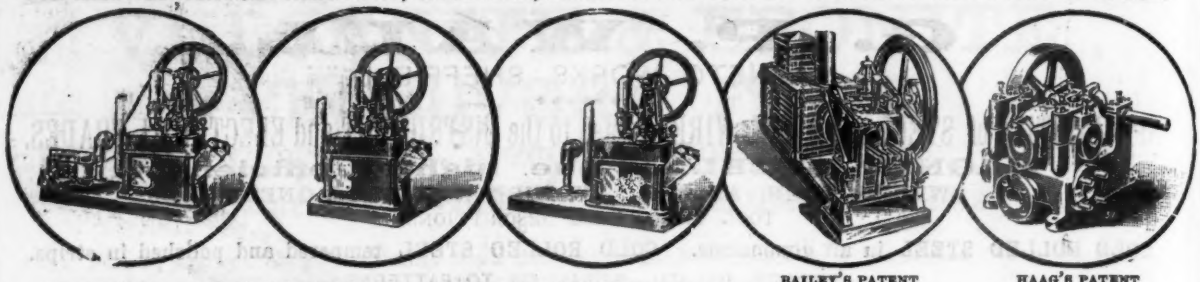
And every Requisite for Electric Lighting and Transmission of Power. 3903

Telegrams: "ARC," TAUNTON.

BAILEY'S MOTORS

Actuated by STEAM, WATER, HOT AIR, PETROLEUM OIL, &c.

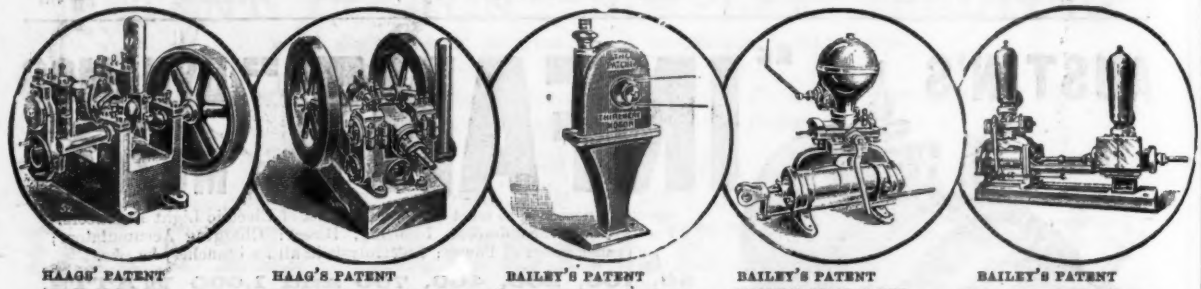
FOR ELECTRIC LIGHT INSTALLATIONS, INDUSTRIAL, DOMESTIC AND STABLE MACHINERY: WATER RAISING &c., &c.



"BAILEY-FRIEDRICH" SAFETY STEAM MOTORS.
Inexplosible Steady-Running, and Portable. Consumes 2 quarts of water per H.P. per day only.

BAILEY'S PATENT
HOT-AIR ENGINE.
No Boiler No Danger! No skilled attendance required!

HAAG'S PATENT
HIGH-SPEED STEAM ENGINE.
For Driving Fans, and other light machinery.



HAAGS' PATENT
WATER MOTOR
May be driven by Town's Pressure or other available water supply.

HAAG'S PATENT
HIGH-PRESSURE WATER MOTOR.
For use in Mines, and places where high water pressures are available.

BAILEY'S PATENT
"THIRLMERE" WATER MOTOR.
Much used for Telephones, Dynamos, and small installations of the Electric Light.

BAILEY'S PATENT
HYDRAULIC ORGAN BLOWER OR WATER ENGINE.
Mostly used for driving the Feeders of Pipe Organs.

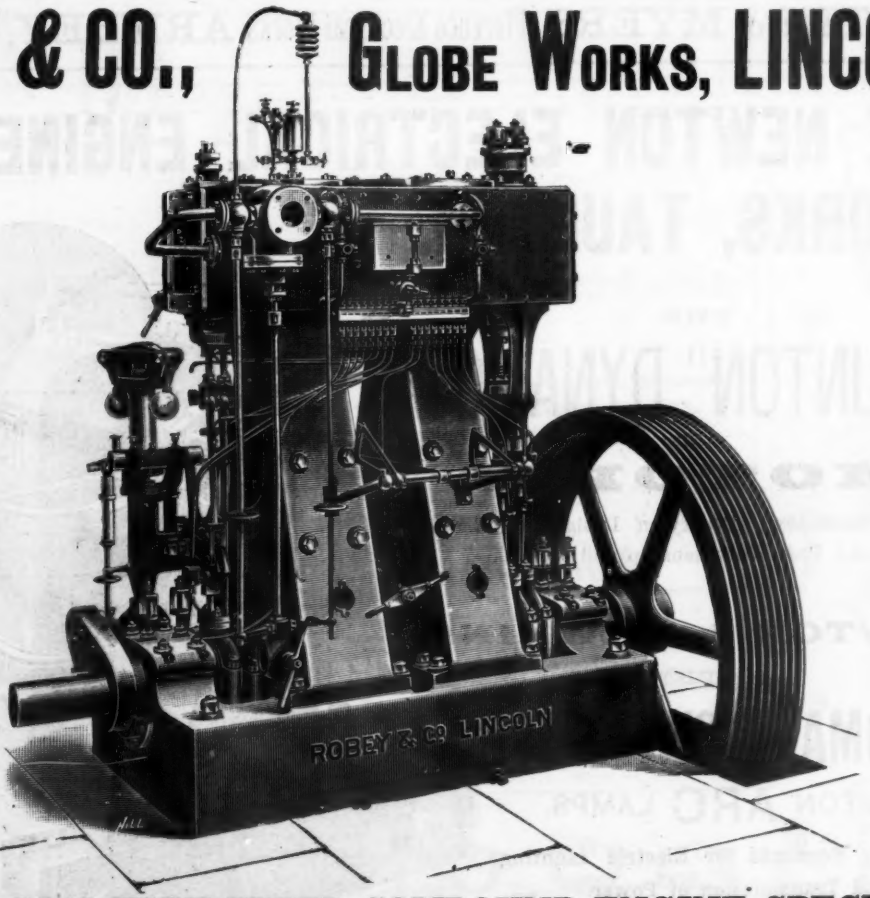
BAILEY'S PATENT
WATER MOTOR PUMPING ENGINE
For Lifting a portion of the wate which drives the Engine to a higher elevation.

JUST PUBLISHED.—"BAILEY'S MOTORS," *an Illustrated Catalogue of the various Motors manufactured by W.H.B. & Co.* **Post Free, 1s.**

W. H. BAILEY & Co., Ltd., Albion Works, SALFORD, Manchester.

3070

ROBEY & CO., GLOBE WORKS, LINCOLN.



ROBEY & CO.'S HIGH-SPEED COMPOUND ENGINE, SPECIALLY ADAPTED FOR ELECTRIC LIGHT INSTALLATIONS.
(SERIES 3).

4059

Telegraphic Address: "ANYWISE, LONDON."

THE NEW DRILLING MACHINE

Will bore Square, Hexagon, or any shape of Hole at one operation. 4154

PRICES AND PARTICULARS FROM

THE SQUARE DRILLING MACHINE COMPANY, Ltd., 35, Parliament Street, LONDON.

CHEMICALS.

ALL KINDS FOR ELECTRICAL WORK, and also for INDIA-RUBBER & GUTTA-PERCHA MANUFACTURERS,

Supplied and Shipped at shortest notice by

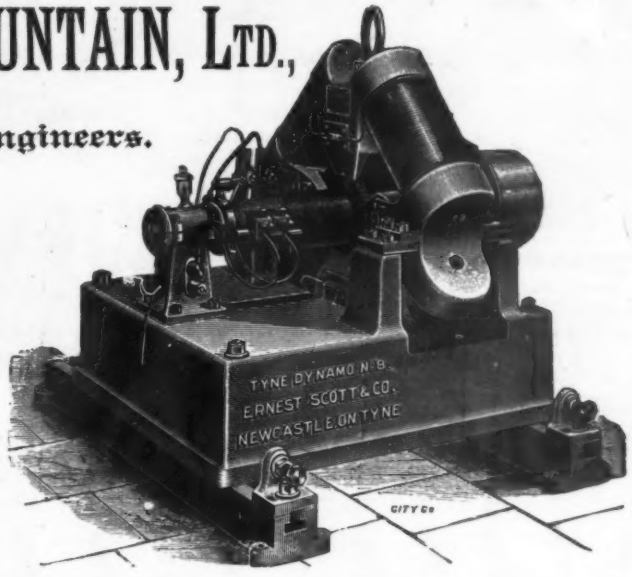
G. BOOR & Co., 1 & 2, Artillery Lane, Bishopsgate, LONDON, E.C.

CONTRACTORS TO THE POST OFFICE WAR OFFICE, ADMIRALTY, INDIA AND NEW ZEALAND OFFICES AND LEADING TELEGRAPH COS.

ERNEST SCOTT & MOUNTAIN, LTD.,

NEWCASTLE-ON-TYNE,

Electrical and General Engineers.



TYNE DYNAMOS,

TYNE ARC LAMPS,

TYNE TRANSFORMERS.

Complete Installations erected by experienced men at home and abroad.

SPECIAL TERMS TO THE TRADE.

Complete Catalogue on application.

Offices:
LONDON: 110, Leadenhall Street.
MANCHESTER: 24, Victoria Buildings.
HUDDERSFIELD: Lancaster Yard, Cloth Hall St.
GLASGOW: 53, Waterloo Street.
NEWCASTLE-ON-TYNE: Close Works.
JOHANNESBURG SOUTH AFRICA.

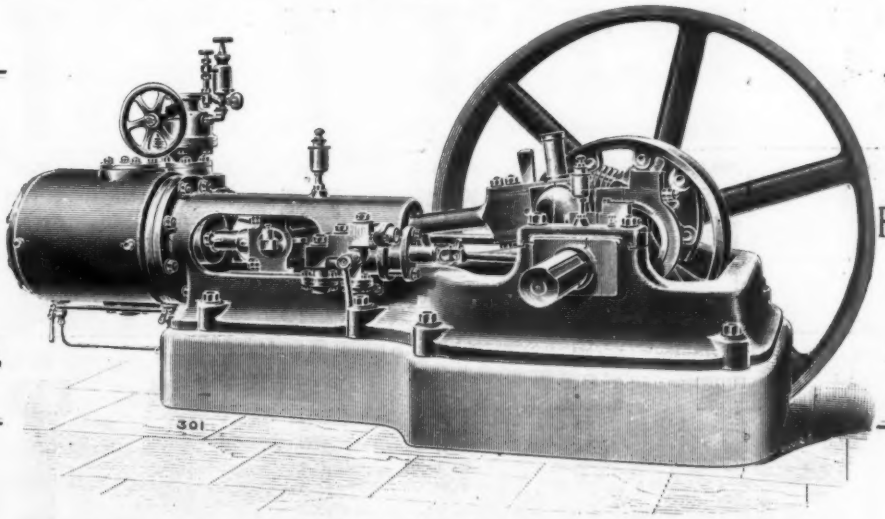
Telegraphic Addresses:
"Boltonite," London.
"Ampère," Manchester.
"Dynamo," Huddersfield.
"Roots," Glasgow.
"Esco," Newcastle-on-Tyne.
"Mulhause," Johannesburg. 4160

MARSHALL, SONS & CO., Ltd.,

BRITANNIA IRON WORKS, GAINSBOROUGH.

London Offices, Showrooms and Stores:—MARSHALL'S BUILDINGS, 79, FARRINGDON ROAD, E.C.

ENGINES for ELECTRIC LIGHTING.



PERFECT REGULARITY in RUNNING.

Improved Horizontal Fixed Engine, with Moore's Patent Crankshaft Governor and Balanced Slide Valve

SPECIALLY ADAPTED FOR ELECTRIC LIGHT WORK.

Telegrams for Works: "Marshalls, Gainsboro'." *Telephone No. 6,648.* *Telegrams for London Office: "Engine, London."*

Illustrated Catalogues, with Current Prices, free on application. 4152

EXCHANGE No. 1140,
Works and Head Offices,
POWNALL ROAD, DALSTON,
LONDON.

FREE TELEPHONES!

No Rental! No Royalty!

Telegraphic Address,
PATELLA, LONDON,
and
PATELLA, GLASGOW.

THE "COMBINATION" TELEPHONE.

The "COMBINATION" TELEPHONE as shown here serves for a thoroughly practical and efficient telephone line.

	£	s	d.
Price for each Station, with Call-Bell and Battery complete, for lines up to 2 miles	2	12	6
Do. do. do. above 2 miles.	3	10	0

PATERSON & COOPER.

POWNALL ROAD, DALSTON, LONDON;
3, PRINCES MANSIONS, VICTORIA STREET LONDON
137, WEST REGENT STREET, GLASGOW · AND
EAST DOCK BUILDINGS, DUNDEE;

At any of which places the instruments can be seen and tested.

PATERSON & COOPER

ELECTRIC LIGHT AND TELEPHONE ENGINEERS,

MANUFACTURERS OF DYNAMOS, ARC LAMPS, MEASURING INSTRUMENTS, &c. 203

Telephone No. 5422. ESTABLISHED 1870. Telegrams: "Flexible, London."

SILVER MEDAL INTERNATIONAL ELECTRIC EXHIBITION. 1882.

PHILLIPS BROTHERS,

Electricians,

OFFICES AND WORKS: THE LEA TELEGRAPH WORKS, HACKNEY WICK, LONDON E.

MANUFACTURERS OF CABLES, WIRES, &c., TO ANY SPECIFICATION.

MULTIPLE CABLES, AERIAL AND SUBTERRANEAN.

Gutta-Percha, India-Rubber, and Compound Wires of every description for Telephone and Electric Bell Work.

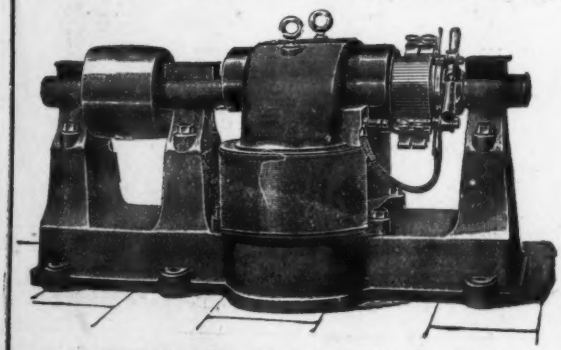
FANCY BRAIDED WIRES OF EVERY DESCRIPTION.

COTTON AND SILK COVERED WIRES FOR DYNAMO MACHINES, MAGNETS, &c., &c. 2177

LAURENCE, SCOTT & Co., Ltd.,

Electrical Engineers, Manufacturers & Contractors,

GOTHIC WORKS, KING ST., NORWICH



"NORWICH" DYNAMOS

("C" AND "D" TYPES).

CONTINUOUS CURRENT TRANSFORMERS.

MOTORS.

Specially Wound Dynamos to charge cells and supply constant E.M.F. to Lamp Mains independently and at the same time.

971 Norwich D-Type Dynamo, with 3 Bearings.

LIBERAL DISCOUNTS TO THE TRADE. AGENTS WANTED

THE INDIA RUBBER, GUTTA PERCHA AND TELEGRAPH WORKS CO.. LTD.

Electrical Engineers and India Rubber and Gutta Percha Manufacturers.

MANUFACTURERS OF

CABLES, WIRES, INSTRUMENTS, INSULATORS, DYNAMO MACHINES, MOTORS, ARC LAMPS & FITTINGS, BATTERIES, CARBONS, TORPEDO APPARATUS.

SPECIALITY.—Underground Electric Light System for High and Low Tension. The only system which has given complete satisfaction.

CONTRACTS entered into for the ERECTION and EQUIPMENT of CENTRAL LIGHTING STATIONS, the LIGHTING of SHIPS, FACTORIES, HOUSES, and the supply of COMPLETE PLANT for ELECTRICAL TRACTION and TRANSMISSION of POWER.

VULCANISED INDIA RUBBER.

HOSE, DRIVING BANDS, STEAM PACKING, WATERPROOF GARMENTS and FABRICS, SHOE SOLES, MATS, VALVES, BRAKE BLOCKS, WHEEL TYRES for CABS, CARRIAGES, BICYCLES, &c. SHEET, WASHERS, BUFFERS, SPRINGS, TUBING, SOLID CORD, FOOTBALL BLADDERS, LAWN TENNIS BALLS, MOULDED GOODS to any Pattern.

EBONITE.

NOT AFFECTED BY VINEGAR OR HYDROCHLORIC OR ACETIC ACID.

SPECIALITIES IN EBONITE FOR CHEMICAL WORKS.

INSULATORS, BATTERY CELLS, SPEAKING TUBES, SHEET and ROD, SURGICAL APPLIANCES, PHOTOGRAPHIC ARTICLES, SCREW STOPPERS, PUMPS.

GUTTA PERCHA.

TUBING, BELTING, BUCKETS, BOSSES for FLAX SPINNING, GOLF BALLS, SHEET, and TISSUE.

ESTIMATES AND PRICE LISTS ON APPLICATION.

HEAD OFFICES.

106, CANNON ST., LONDON, E.C.

WAREHOUSES.

100 TO 104, CANNON ST., LONDON, E.C.

BRANCHES.

MANCHESTER	4, Fountain Street.	DUBLIN	15, St. Andrew Street.
LIVERPOOL	54, Castle Street.	PORTSMOUTH	49, High Street.
GLASGOW	8, Buchanan Street.	BRISTOL	28, Clare Street.
BRADFORD, YORKSHIRE	35, Kirkgate.	NEWPORT, MON	119, Dock Street.
SHEFFIELD	64A, High Street.	CARDIFF	Pierhead Chambers, Bute Docks.
BIRMINGHAM	Corporation Street.	NEWCASTLE-ON-TYNE	6, Neville Street.
BELFAST	33, High Street.	NORTH SHIELDS	Borough Road.
		LEEDS	9, Trinity Street.

WORKS.

SILVERTOWN, ESSEX. PERSAN-BEAUMONT, FRANCE.

TELEGRAPH ADDRESSES.

HEAD OFFICE—"Silvergray, London."
BRANCHES—"Silvergray" (followed by Name of Town).

WORKS—{ Silvertown, "Graysilver, London."
{ Persan-Beaumont, "India, Beaumont-sur-Oise."

7777

Printed by E. KNIGHT, 18 and 19, Middle Street, E.C., and Published by the Proprietors, H. ALABASTER, GATEHOUSE & Co., at 22, Paternoster Row, London.